

Monitoring the effectiveness of tidal wetland restoration for the benefit of native fishes

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California Department of Fish and Wildlife



Acknowledgments

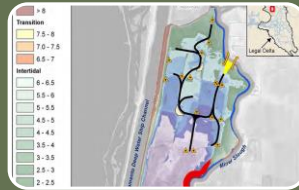
- ▶ Funding: State Water Contractors through DWR
- ▶ Interagency Ecological Program SMT and Tidal Wetland Monitoring PWT
- ▶ Fish Restoration Program
 - ▶ DWR implementers: esp. Dennis McEwan, Laura Flournoy, Dan Riordan, Ling Chu, Bonnie Irving, Joy Khamphanh, Heather Green, Caitlin Roddy, Elaine Jeu
 - ▶ CDFW implementers: Jim Starr, Gina Van Klompenburg, Phillip Poirier, Alison Furler, Andy Rockriver
 - ▶ Past and present members of the CDFW FRP Monitoring Team: Alice Low, Dave Contreras, Trishelle Tempel, Rosemary Hartman, Jared Mauldin, Matt Siepert, Alison Furler, Bonnie Wang, Ryan Kok, Sunny Lee, Kyle Griffiths, Dan Ellis





Introduction

- Wetlands of the Delta and Suisun Marsh, past and present
- Fish Restoration Program



Why?

- Restoration
- Monitoring



What?

- Sites
- Questions
- Metrics



How?

- General Principles
- Methods



Conclusion

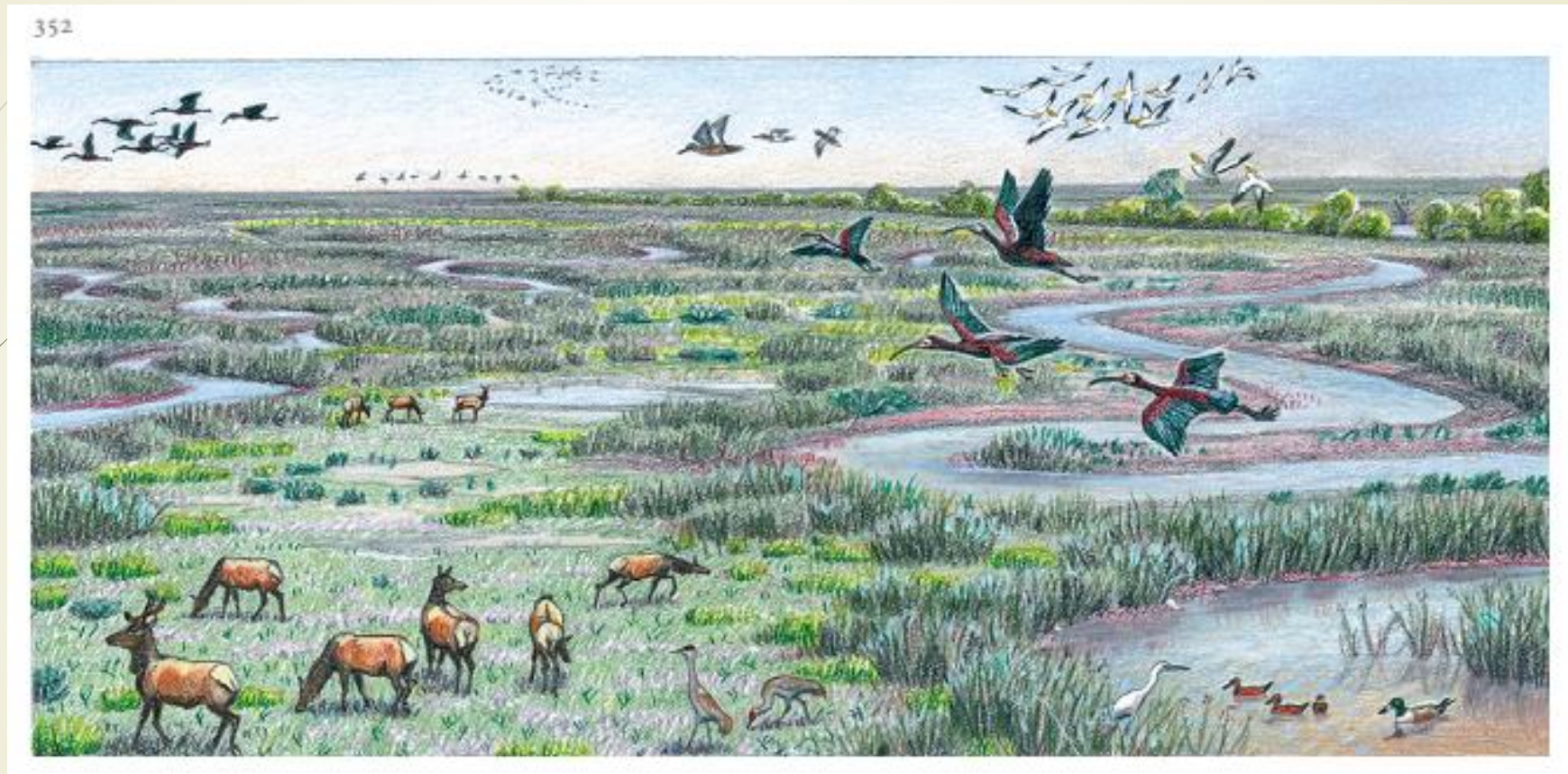
- Monitoring long term
- Constraints
- How ISB review can help

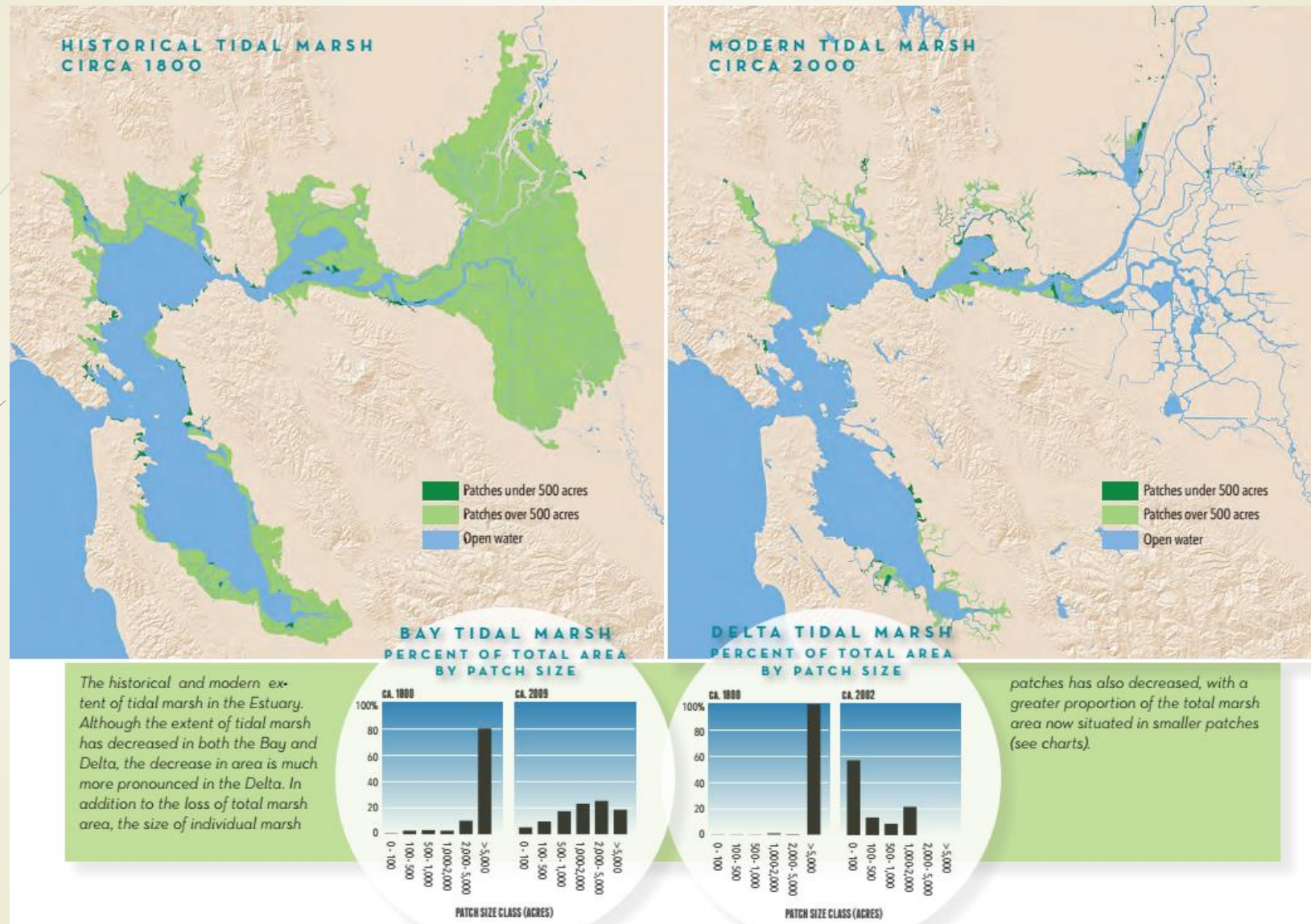
Upper San Francisco Estuary

- Sacramento-San Joaquin Delta
- Suisun Marsh



Figure 1-2
The Delta Watershed and Areas Receiving Delta Water

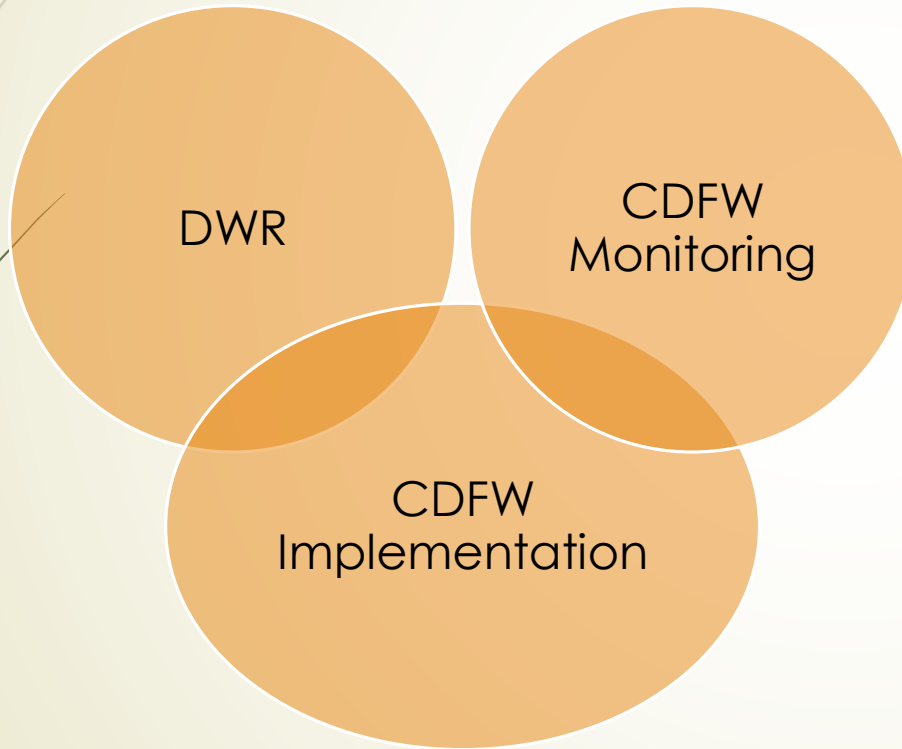




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Fish Restoration Program



IEP Tidal Wetland Monitoring Project Work Team



Why?

- ❖ Tidal wetland restoration
- ❖ Monitoring



I WANT DWR

To restore 8,000 acres
of tidal wetlands

Reasonable and Prudent Alternatives / ITPs

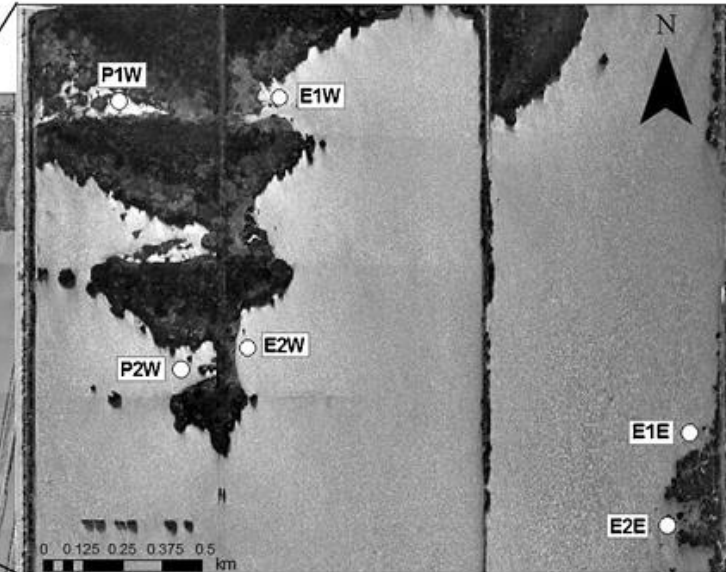
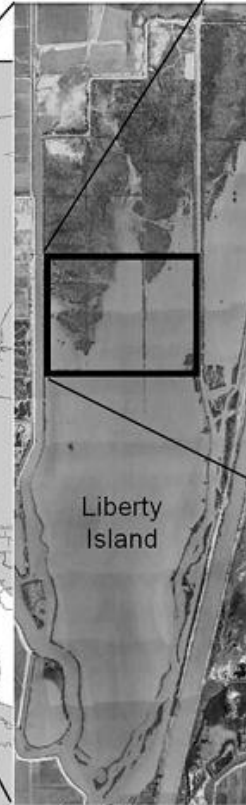
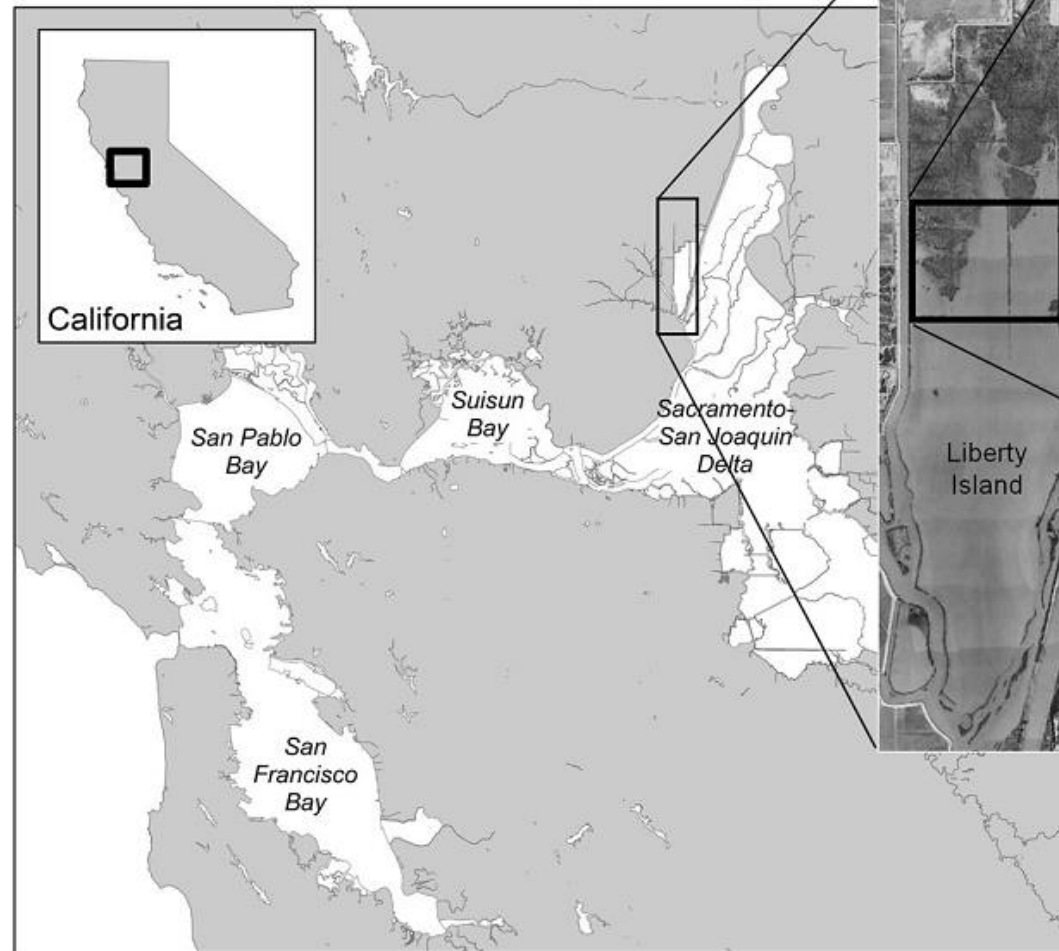
- USFWS 2008 (Delta Smelt) - Habitat Component 4: 8,000 acres in Delta and Suisun Marsh
- NMFS 2009 (salmonids) - Action I.6.1: rearing habitat
- CDFW 2008 (Longfin Smelt) – Condition 7.1: 800 acres mesohaline



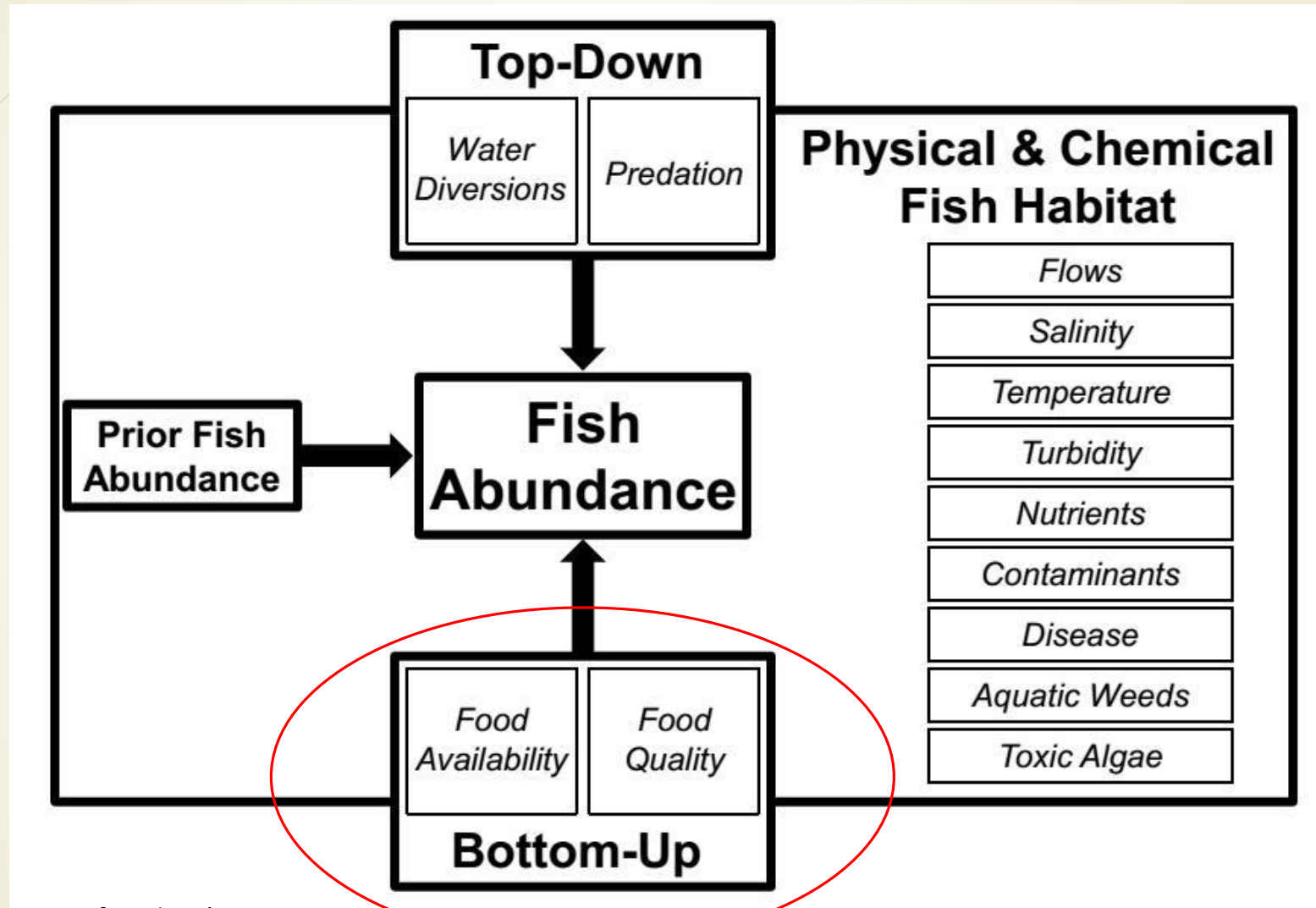
Rearing habitat



Habitat?



Whitley and Bollens, 2014. Fish assemblages across a vegetation gradient in a restoring tidal freshwater wetland: diets and potential for resource competition. *Env. Biol. Fish.* 97

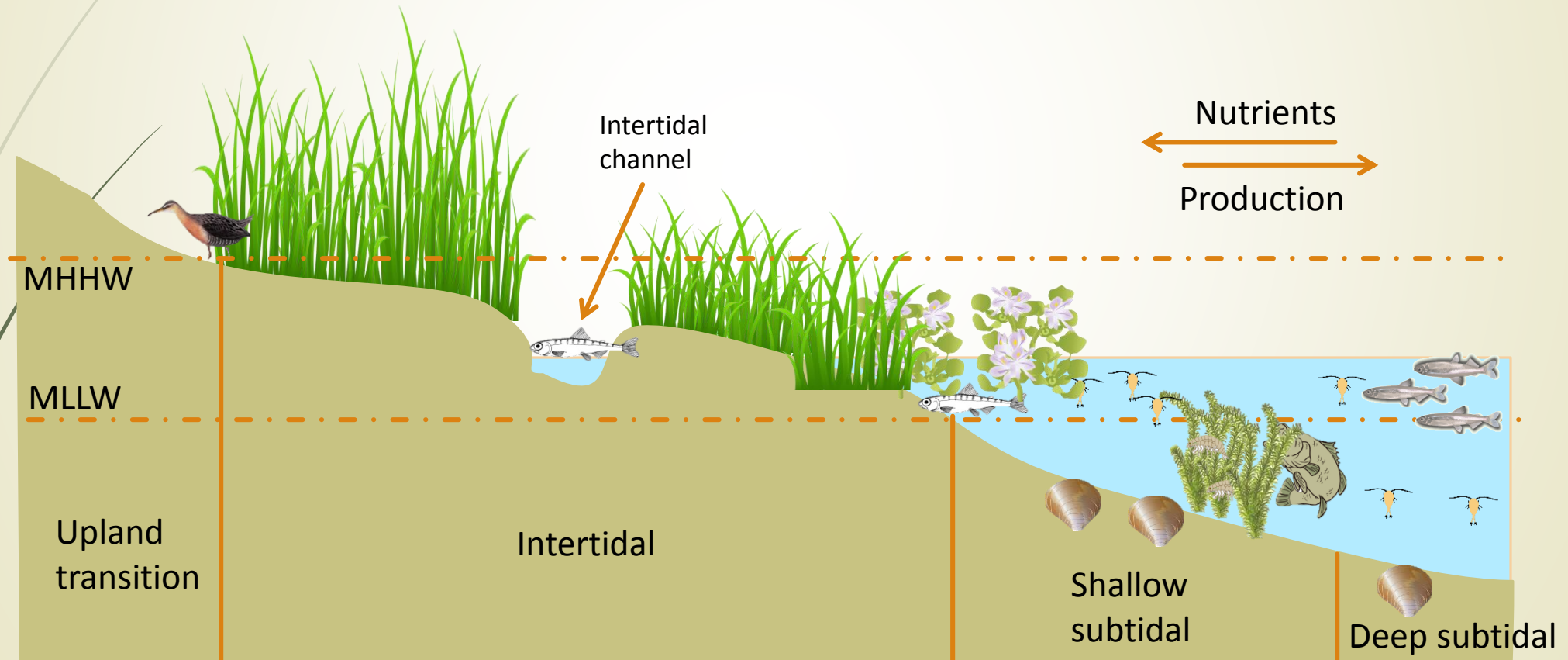


Sommer et al. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32.

Productivity



Wetland Subsidies



Fish Restoration Program objectives

- ▶ Restore 8,000 acres of intertidal...habitat in the Delta and Suisun Marsh...to enhance food production and availability for native Delta fishes;
- ▶ Restore processes that will promote primary and secondary productivity and tidal transport of resources to enhance the pelagic food web in the Delta;
- ▶ Increase the amount and quality of salmonid rearing habitat;
- ▶ Increase through-Delta survival of juvenile salmonids...

Why?

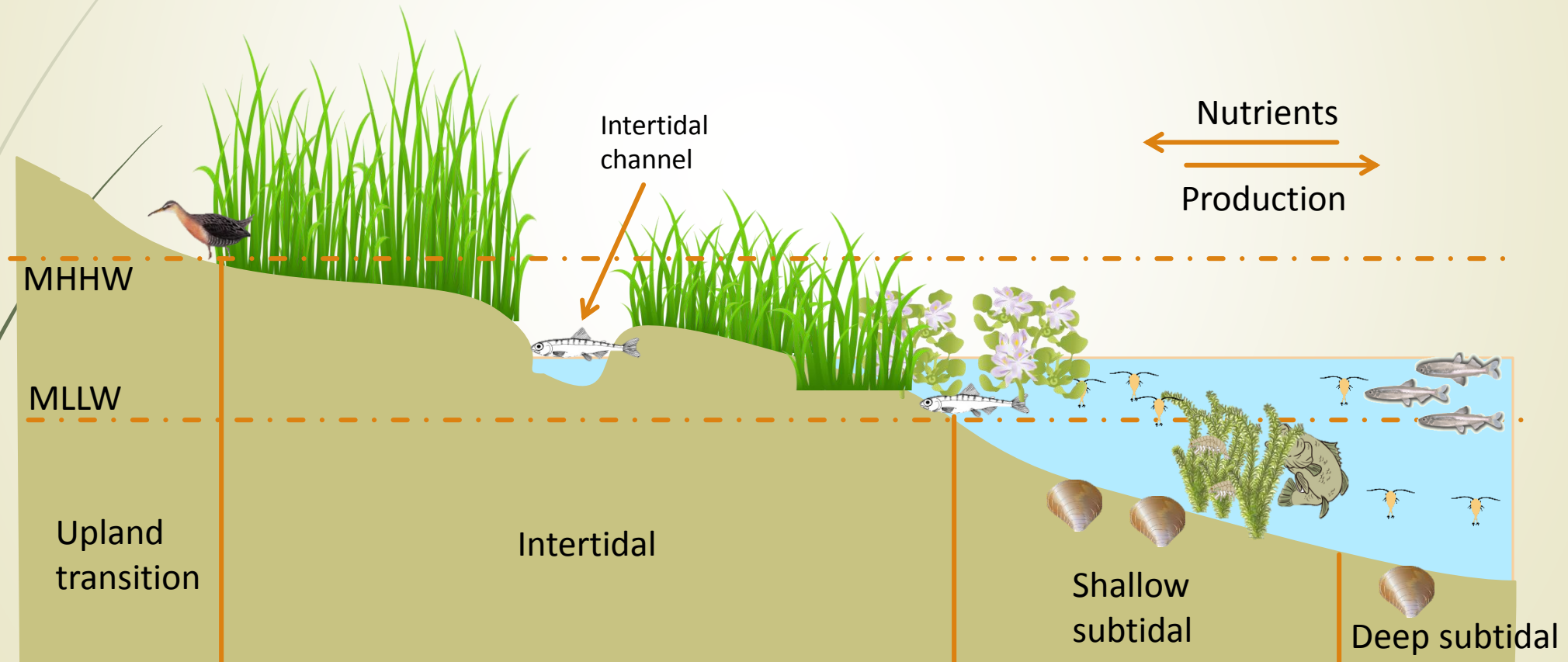
- ❖ Tidal wetland restoration
- ❖ Monitoring



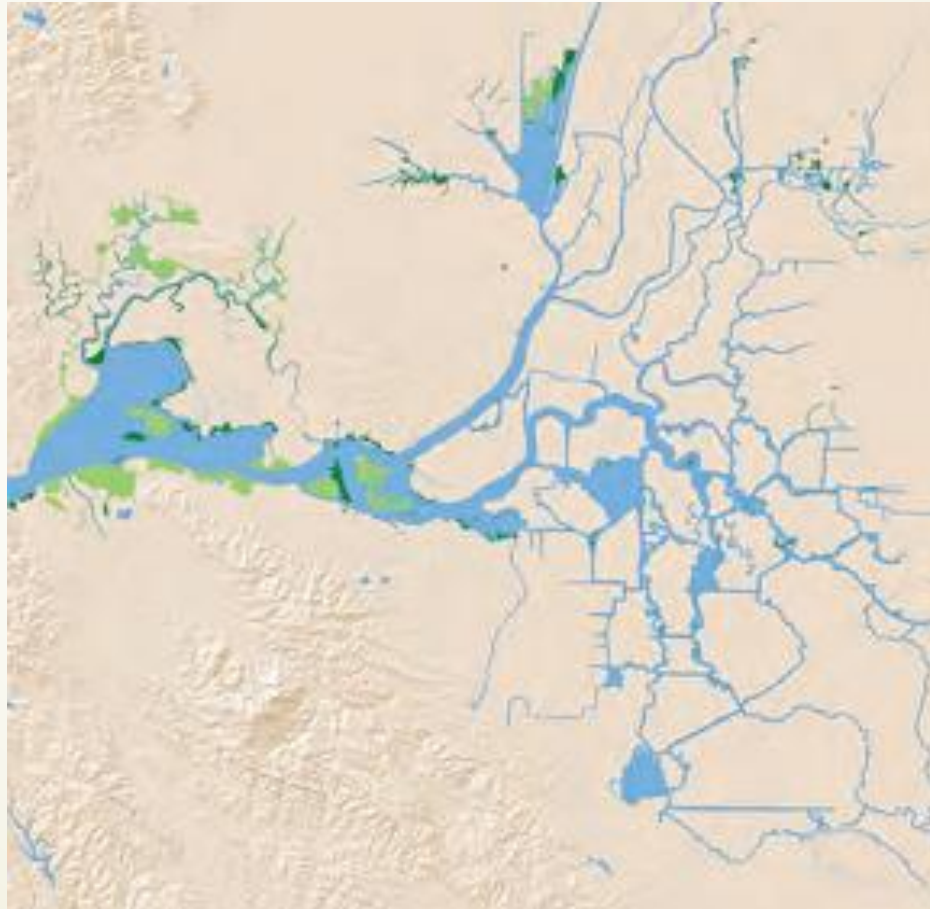
Monitor!

Effectiveness Monitoring

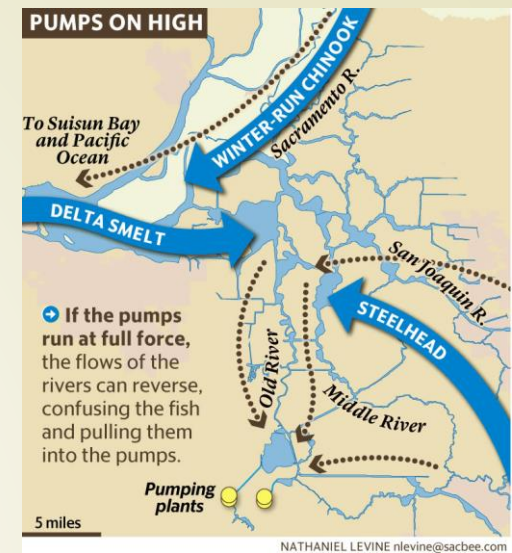
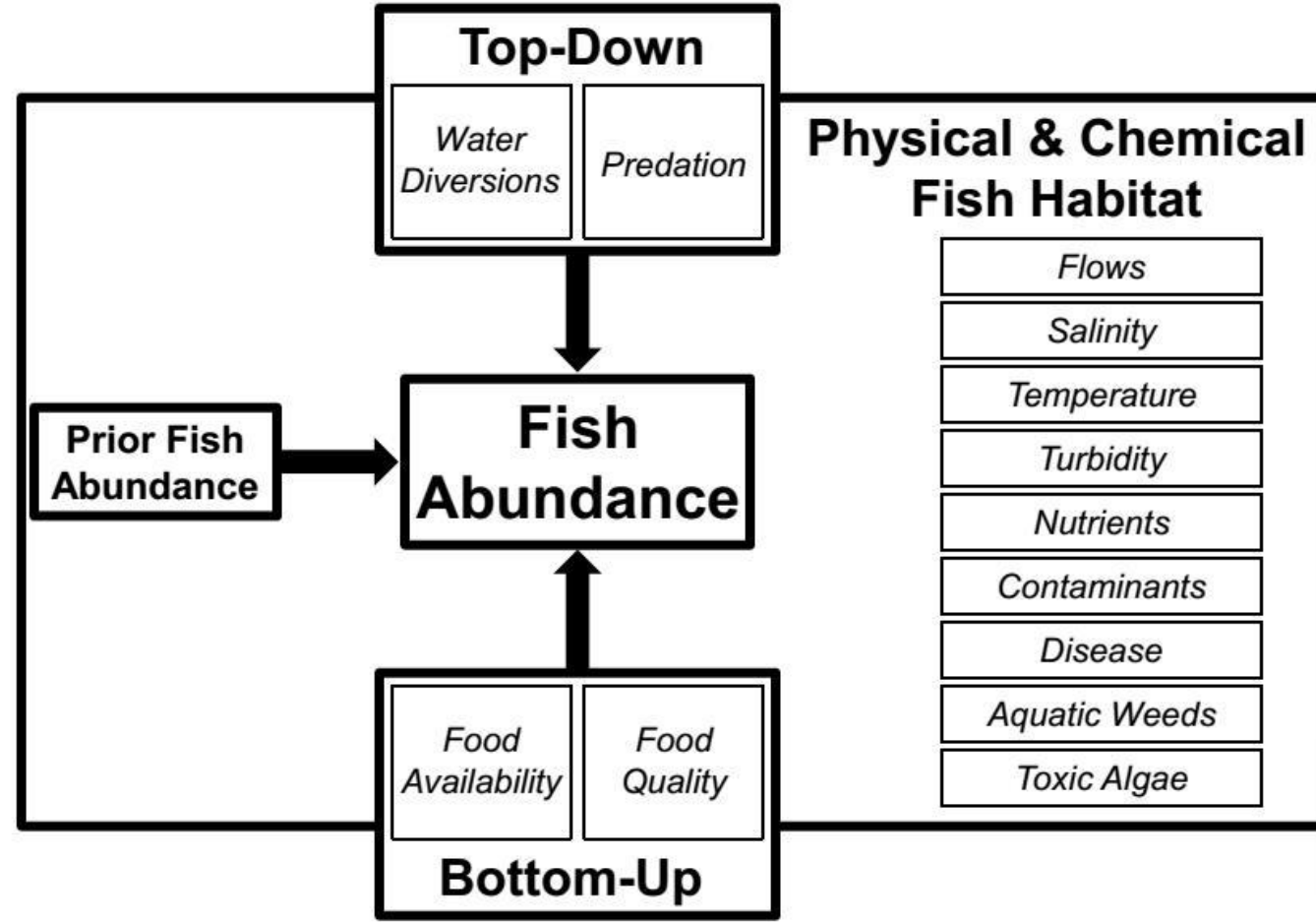
- Meeting objectives?
- Address uncertainties



Uncertainty – historic and current function



Uncertainty – novel system



Sommer et al. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32.

Uncertainty – variability

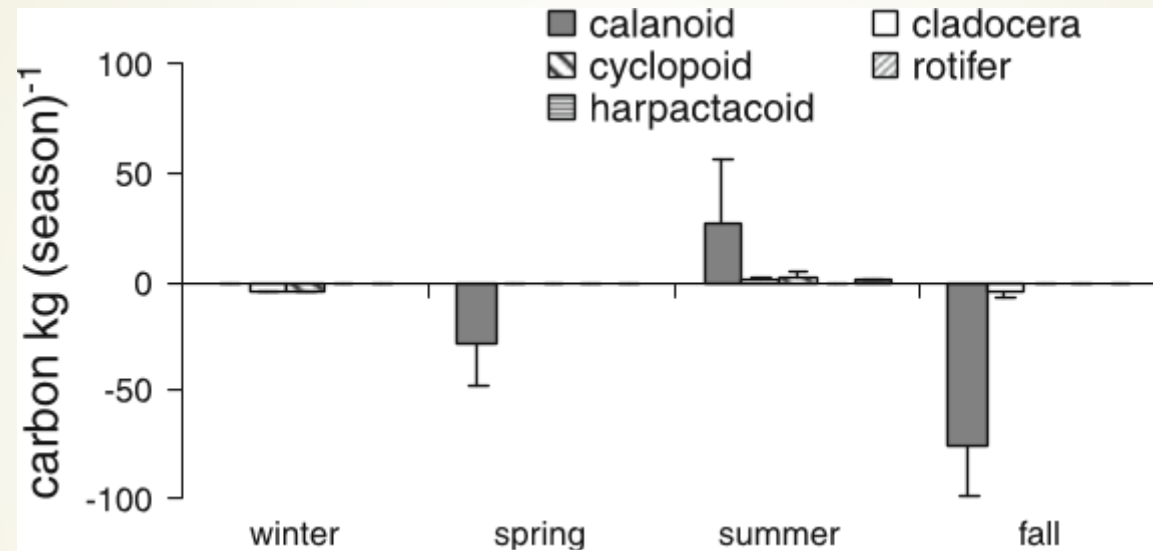
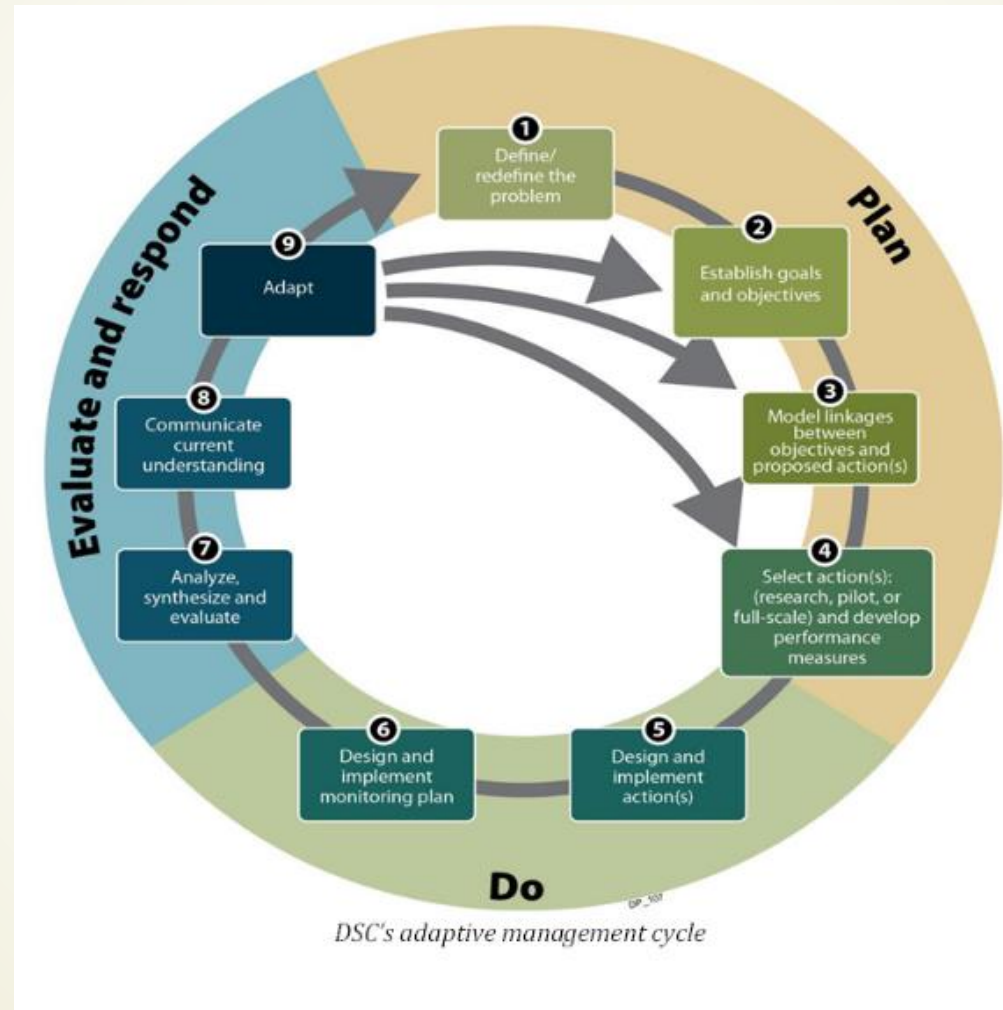


Fig. 6 Monthly average and 75 and 25% percentiles for zooplankton carbon flux among zooplankton groups for four stations in Main Pond between July 2004 and June 2005, $n = 24$. Positive flux values indicate storage and negative flux values indicate export.

Lehman et al. 2010. The freshwater tidal wetland Liberty Island, CA was both a source and sink of inorganic and organic material to the San Francisco Estuary. *Aquat. Ecol.* 44

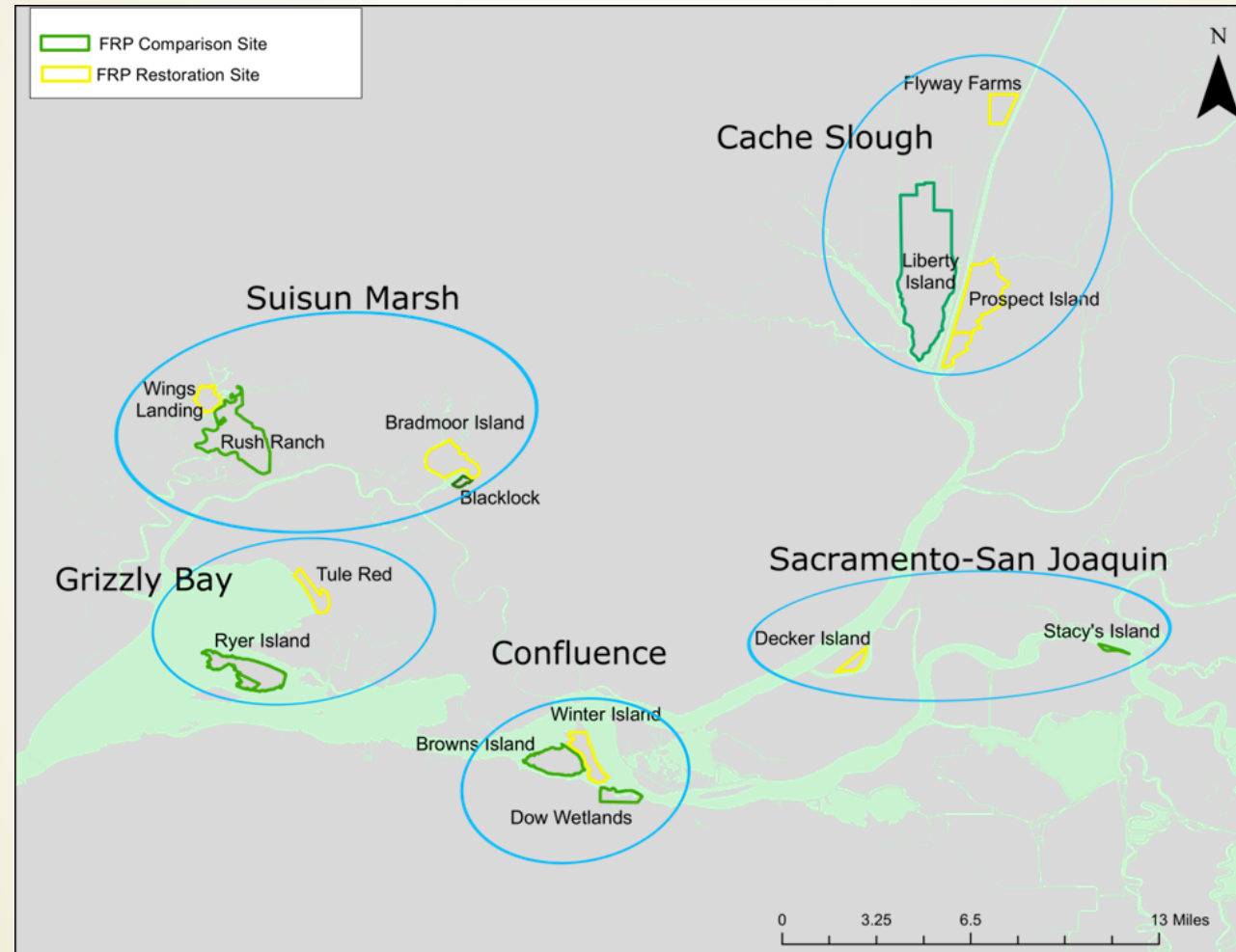
Learn and do better



What?

- ❖ Sites
- ❖ Questions
- ❖ Metrics

Fish Restoration Program Sites

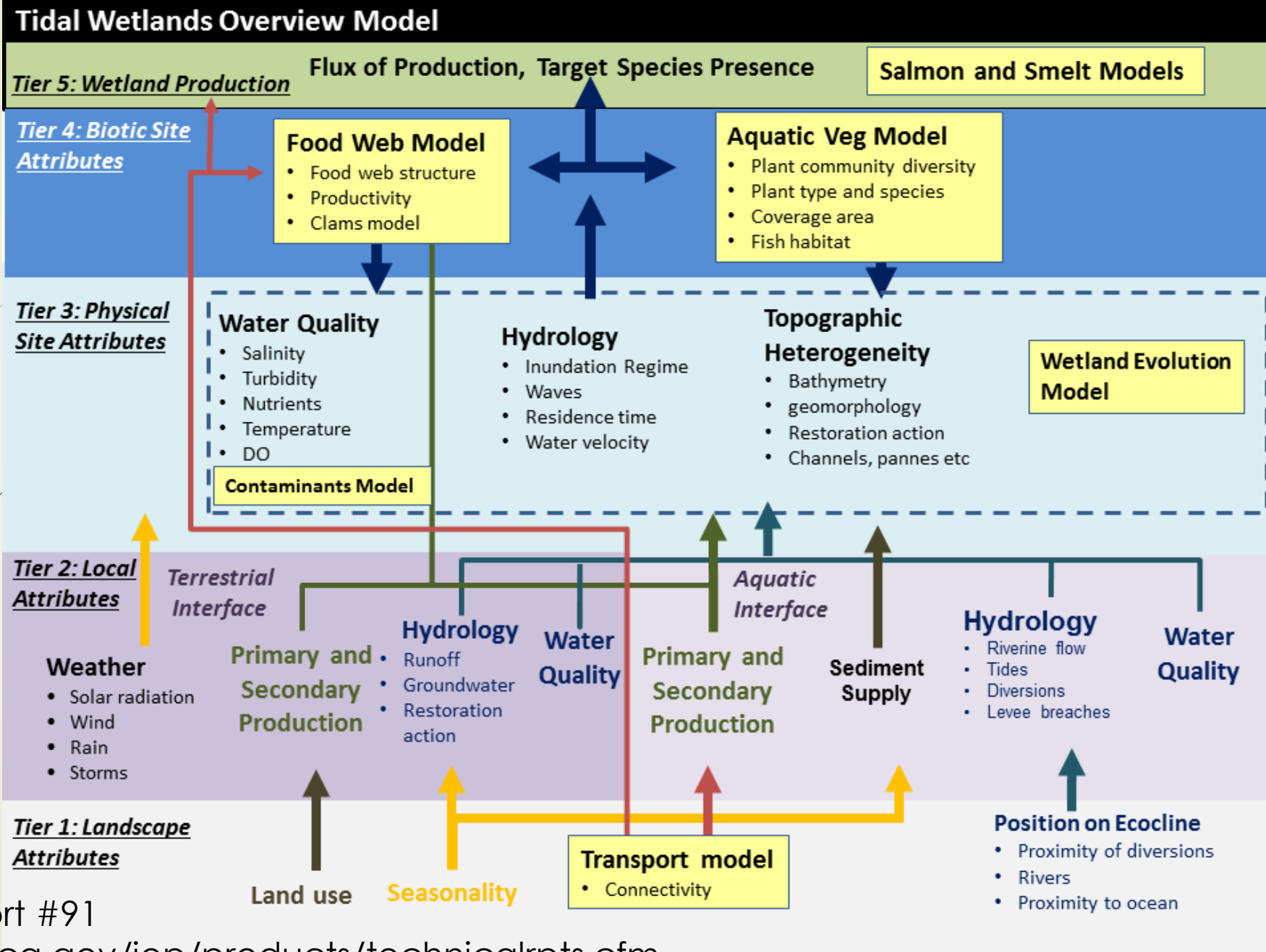


Monitoring

- ▶ Focus on fish food
(program/project objectives)
- ▶ Ask for help
 - ▶ Conceptual Models
 - ▶ Hypotheses, Metrics, Methods
- ▶ Provide help
 - ▶ Methods testing
 - ▶ Framework for monitoring plan development
 - ▶ Data sharing

Interagency Ecological Program
Tidal Wetland Monitoring
Project Work Team







Tier 1: Landscape Attributes

Land use

Seasonality

Transport model

- Connectivity

Position on Ecocline

- Proximity of diversions
- Rivers
- Proximity to ocean

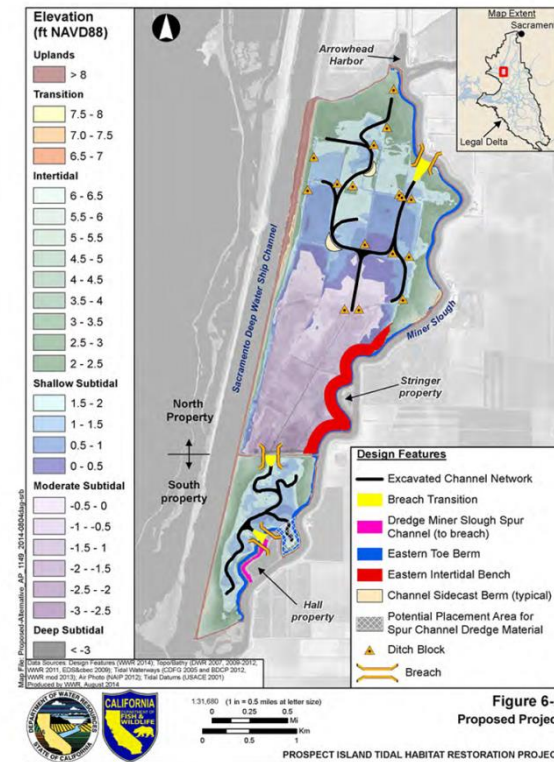
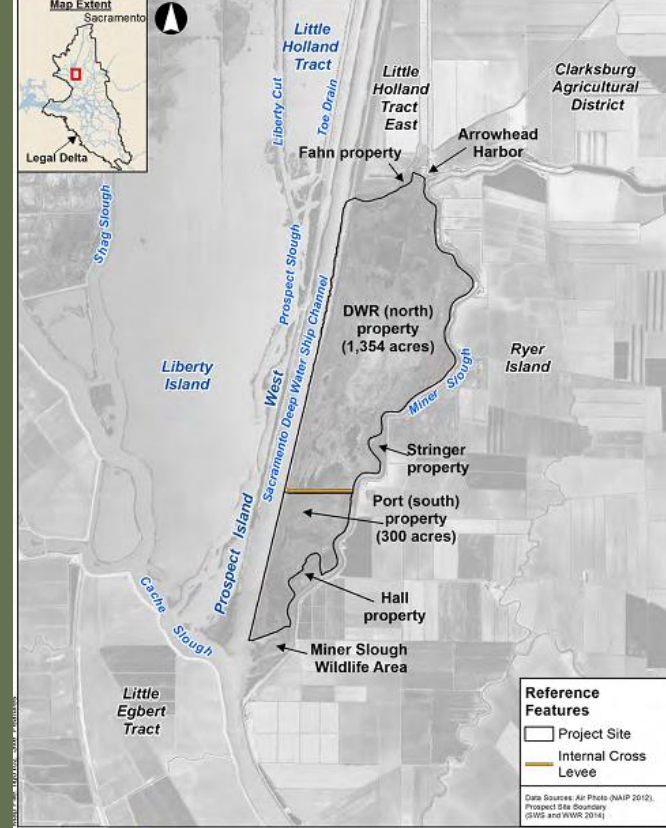


Figure 6-2
Proposed Project

Tier 2: Local Attributes

Terrestrial Interface

Weather

- Solar radiation
- Wind
- Rain
- Storms

Primary and Secondary Production

Hydrology

- Runoff
- Groundwater
- Restoration action

Water Quality

Primary and Secondary Production

Sediment Supply

Aquatic Interface

Hydrology

- Riverine flow
- Tides
- Diversions
- Levee breaches

Water Quality



**Tier 3: Physical
Site Attributes**

Water Quality

- Salinity
- Turbidity
- Nutrients
- Temperature
- DO

Contaminants Model

Hydrology

- Inundation Regime
- Waves
- Residence time
- Water velocity

**Topographic
Heterogeneity**

- Bathymetry
- geomorphology
- Restoration action
- Channels, pannes etc

**Wetland Evolution
Model**



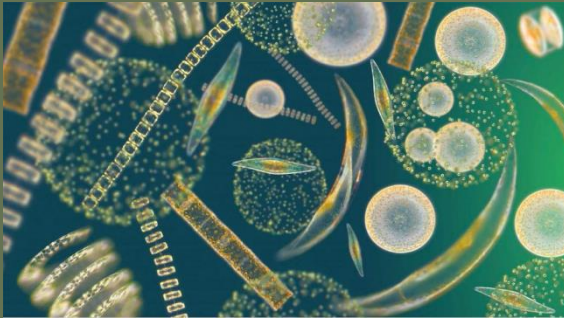
Tier 4: Biotic Site Attributes

Food Web Model

- Food web structure
- Productivity
- Clams model

Aquatic Veg Model

- Plant community diversity
- Plant type and species
- Coverage area
- Fish habitat







Hypothesis overview



Physical Habitat "P"

- Topography
- Elevation

Aquatic Vegetation

- Colonization
- Propagation
- Hydrology
- Soil
- Light

establishment

- Seasonality
- Accretion
- Water quality
- Fish community

Effects on

Fish

- Capacity – structure
- Capacity – H₂O
- Access
- Presence
- Refuge

Food Resources "F"

On-site

- Nutrients
- 1° Productivity
- 2° Productivity

Fish Use

- Zooplankton
- Detrital path
- Condition

Flux

- Nutrients
- 1° Productivity
- 2° Productivity

Stressors "S"

- HABs
- Clam biomass ↑
- Clams ↑, food ↓
- ↑ non-natives
- ↑ non-natives, natives ↓
- Birds and mammals

Contaminants

- Land use
- ↓ 1° productivity
- ↓ 2° productivity
- Sublethal fish effects
- Bioaccumulation

Contaminants

- Less bioavailable
- Turbidity ↑ sequestration
- Plants ↑ sequestration
- Degradation

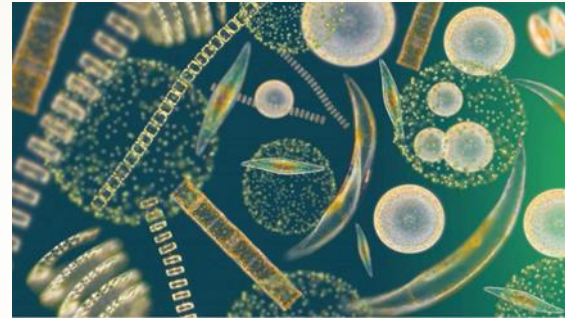
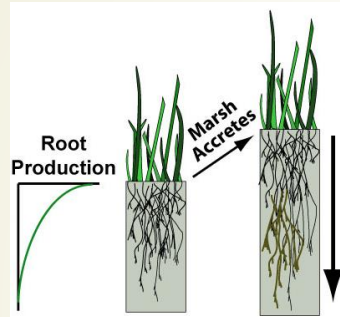


http://www.water.ca.gov/iep/about/tidal_wetland_monitoring.cfm

Hypotheses

- Capacity
- Opportunity
- Realized function
- **Choose and modify based on goals and objectives of project/program**

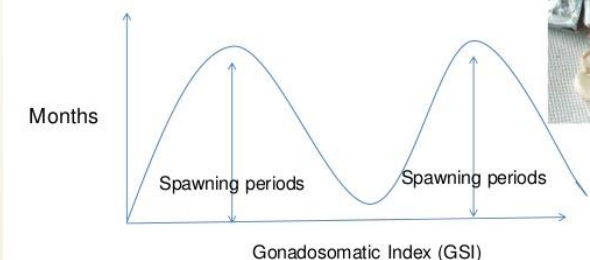
Metrics -Primary, Triggered, Higher Function



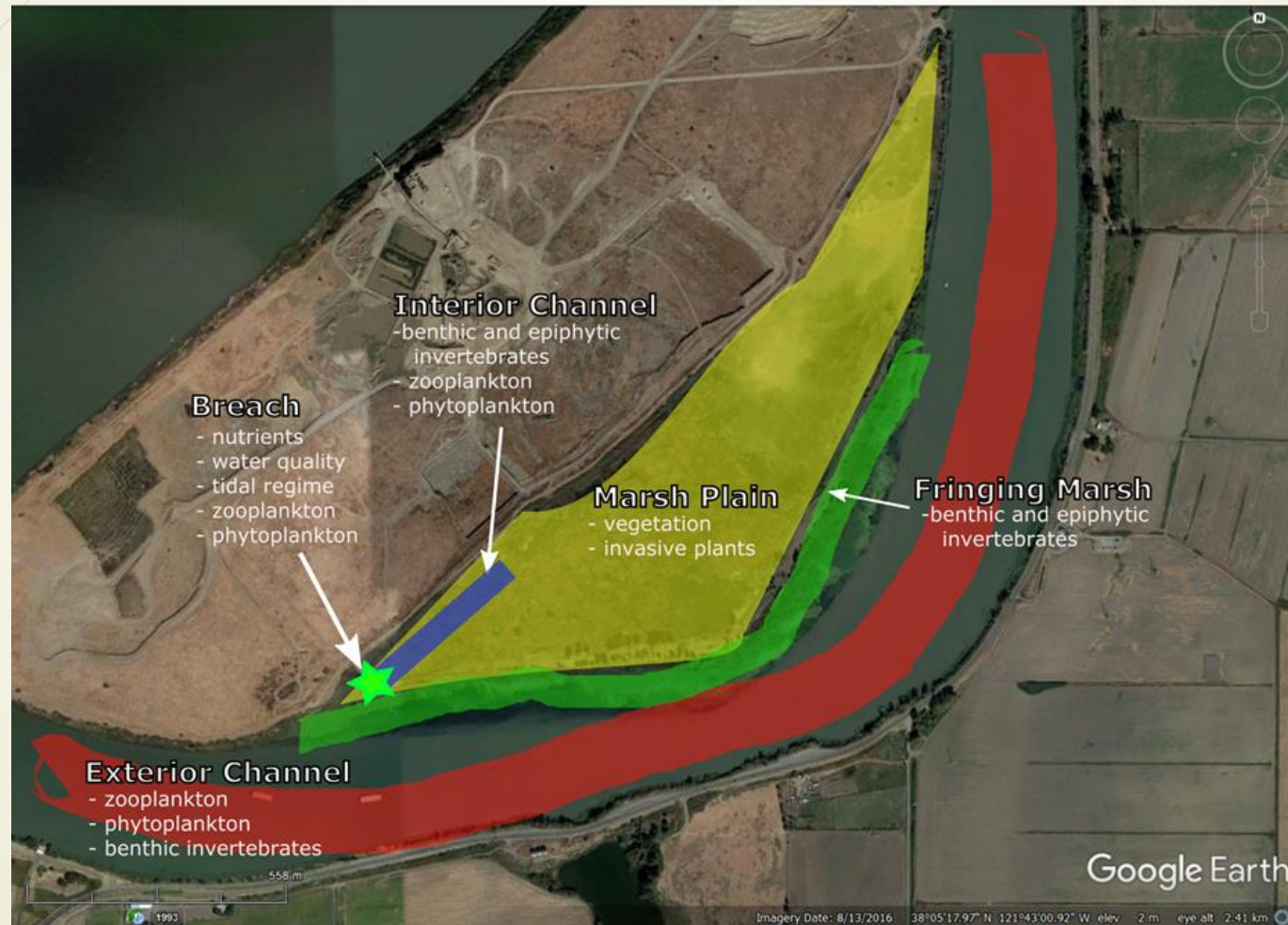
CONDITION INDEX

GONADOSOMATIC INDEX (GSI)

- Fish body weight and weight of gonad
- Identifying days and seasons of spawning → ovaries of females increase in size just prior to spawning.



Typical FRP project metrics

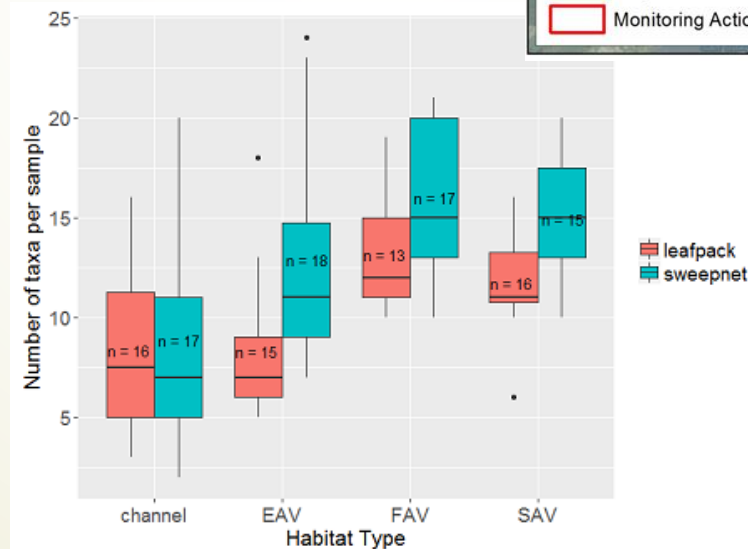


How?

- ❖ General principles
- ❖ Methods
- ❖ Constraints

General principles

- Before – After – Control - Impact
- Efficient
 - Variability and sample sizes
 - Collaboration and coordination
- Transparent
 - Documentation
 - Data sharing

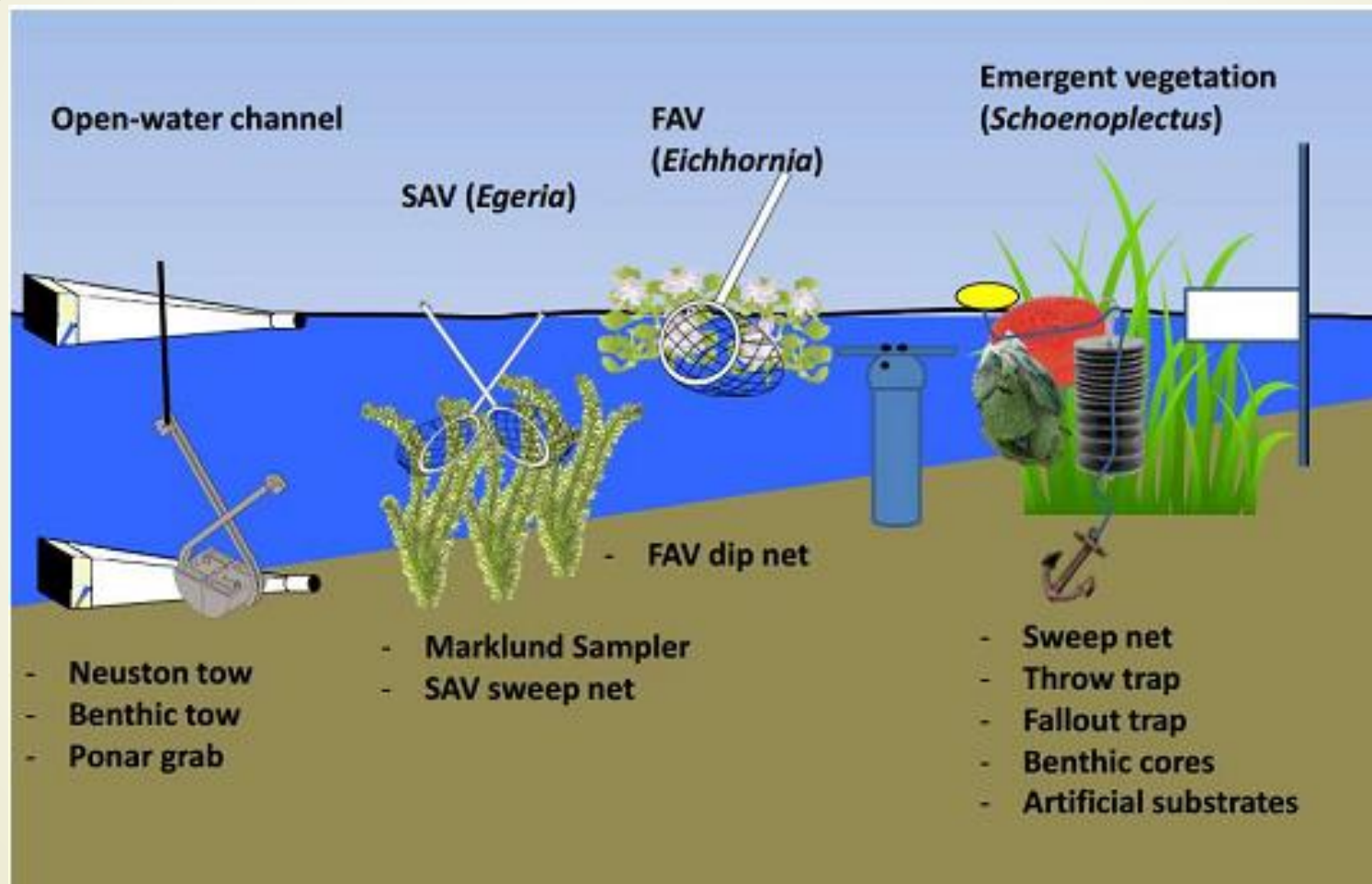


Sampling methods/gears

- Meso- and Macro-Zooplankton
- Other Macroinvertebrates ?
- Fish



Sampling macroinvertebrates?



What works well in one habitat...



Smee. 2016. Nueces Bay Marsh Restoration – Post Construction Assessment

...doesn't necessarily work well in another.

Me in *Spartina*



Me in tules



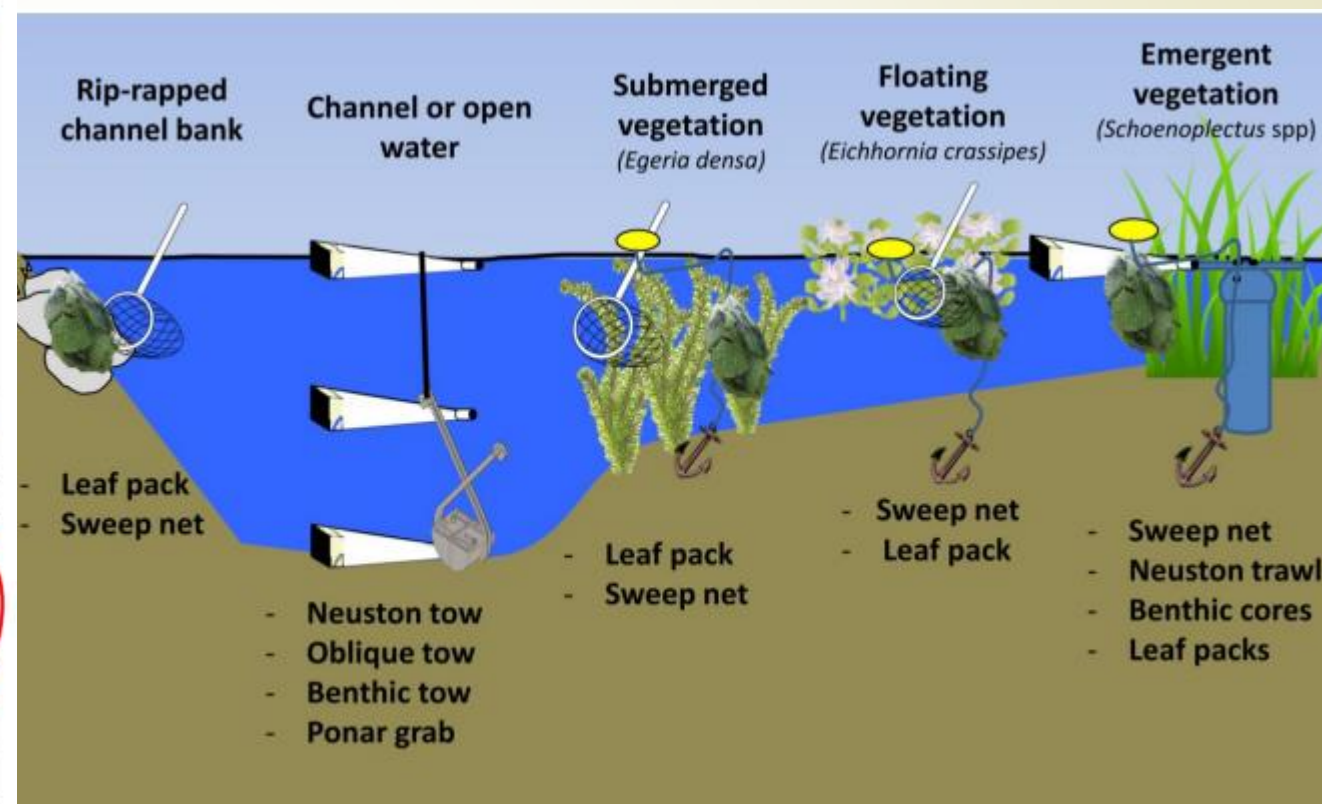
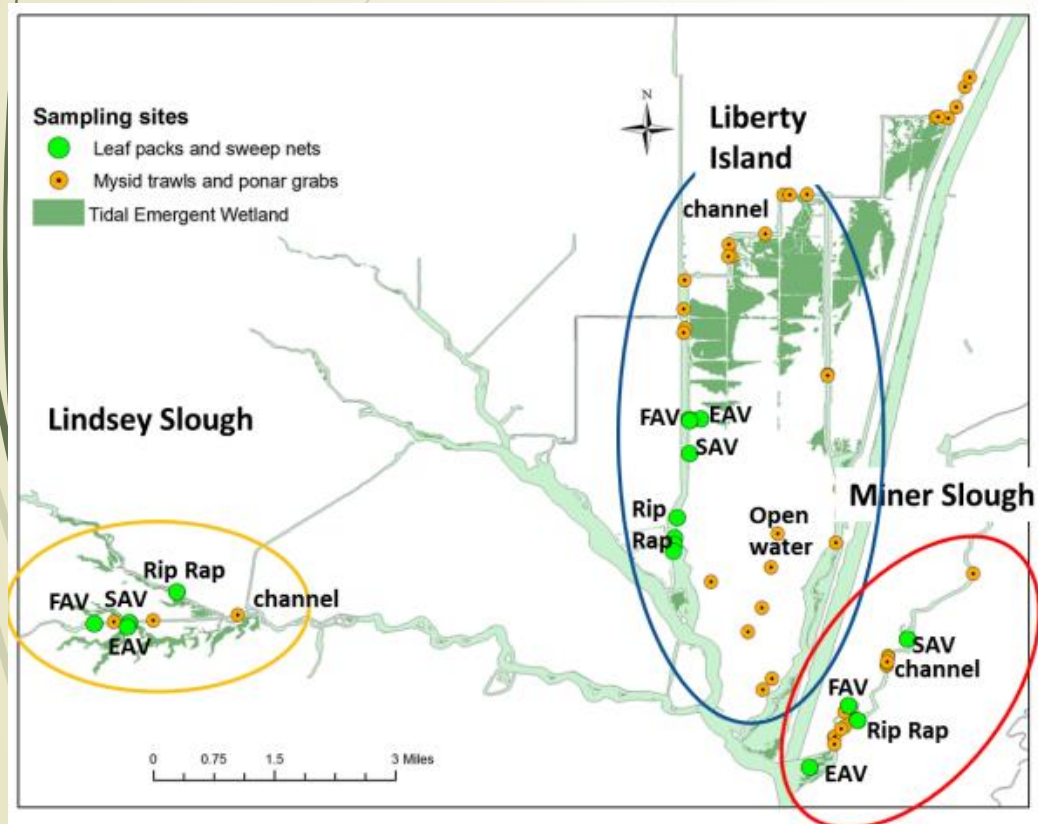
FRP Monitoring Pilot Phase I Final Report:
<http://www.water.ca.gov/environmentalservices/frpa.cfm>

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Sampling macroinvertebrates

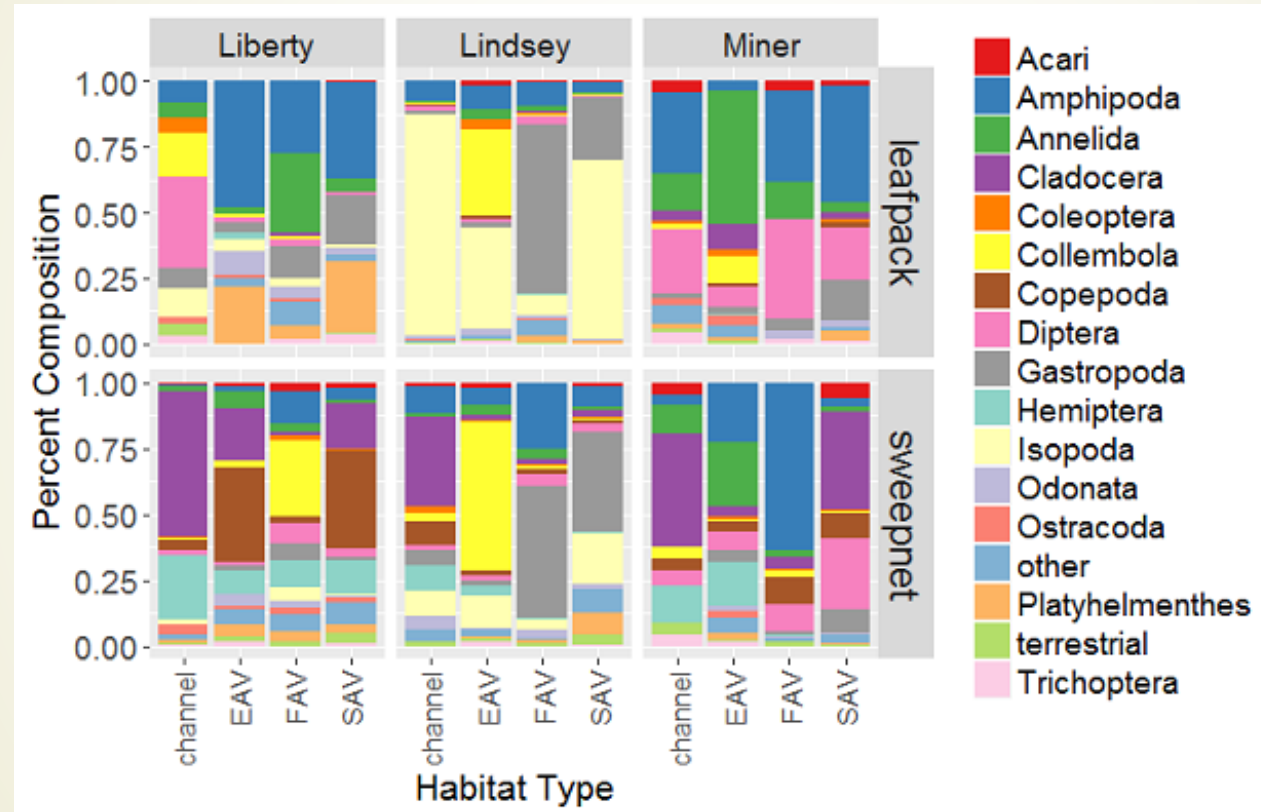
Pilot Phase II, 2016

- Goal: Distinguish between habitat types and wetland sites



Sampling macroinvertebrates

- Goal: Distinguish between habitat types and wetland sites



FRP Monitoring Pilot Phase II Final Report:
<http://www.water.ca.gov/environmentalservices/frpa.cfm>



Sampling methods/gears

- Meso- and Macro-Zooplankton
- Other Macroinvertebrates
- Fish ?

Phase I - 2015 Fish Gear Exploration

Larval Fish Sampling

- Sled vs ~~Light Traps~~

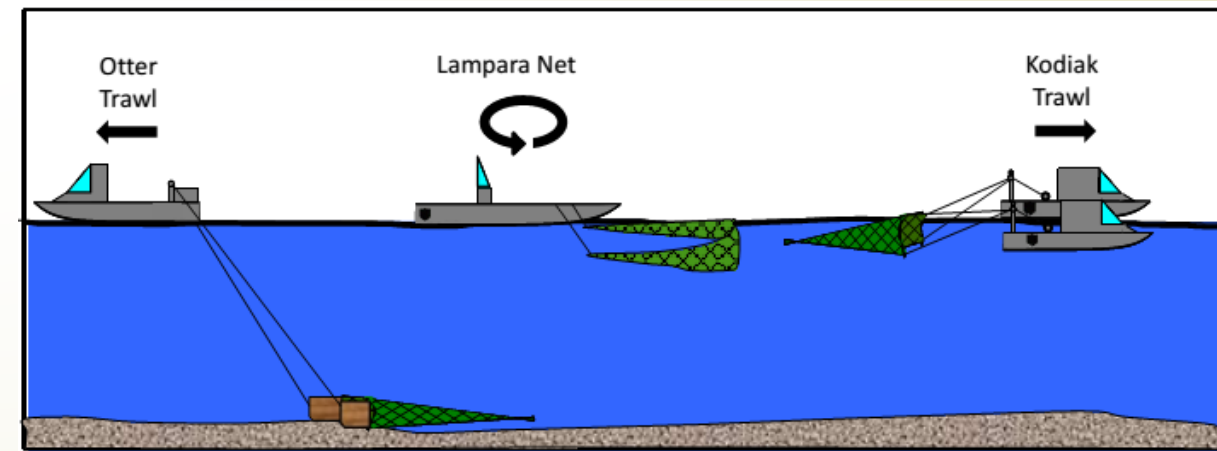


Littoral Non-Vegetated

- Beach Seine (USFWS) vs Lampara Haul

Open Water

- Otter Trawl (UC Davis) vs Kodiak Trawl vs Lampara Haul



Phase II - 2016 Fish Gear Exploration

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Larval Fish Sampling

- Surface vs Oblique trawls

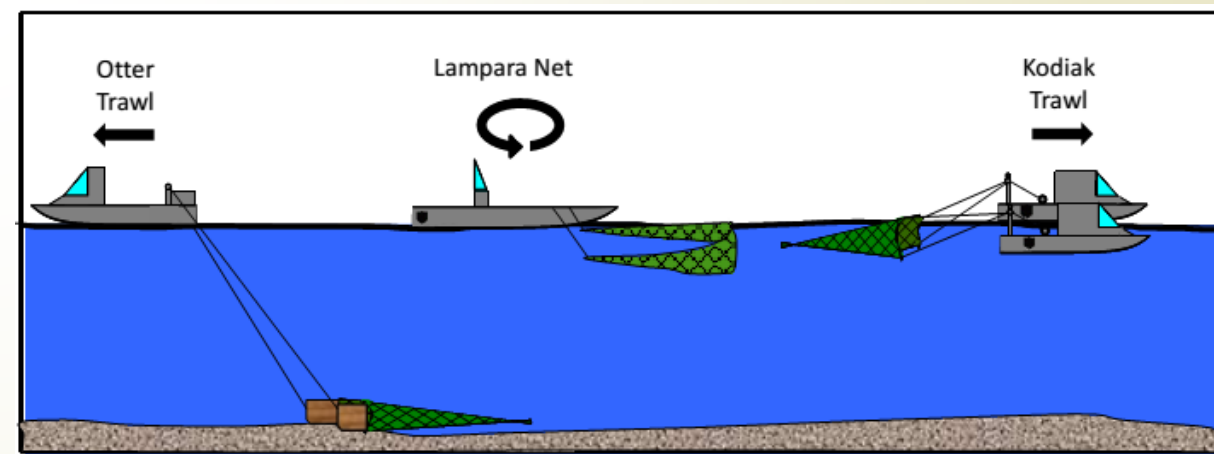


Littoral Non-Vegetated

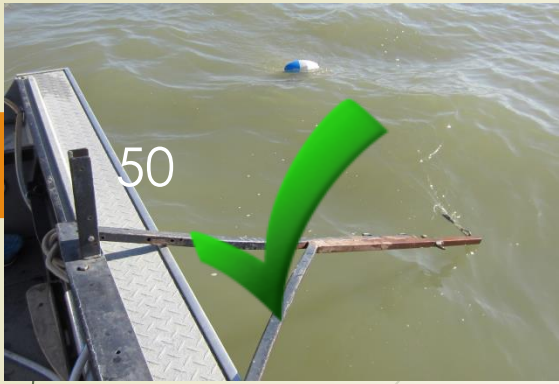
- Beach Seine (USFWS) vs Lampara Haul

Open Water

- Otter Trawl (UC Davis) vs Kodiak Trawl vs Lampara Haul



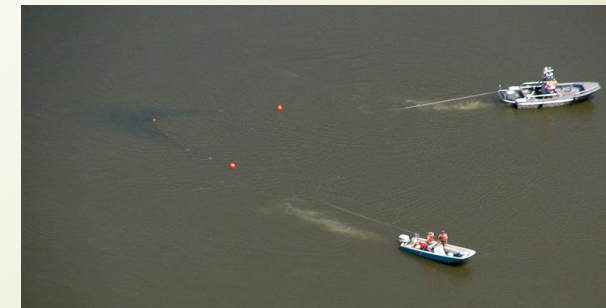
Larval Fish Sampling



Littoral Fish Sampling

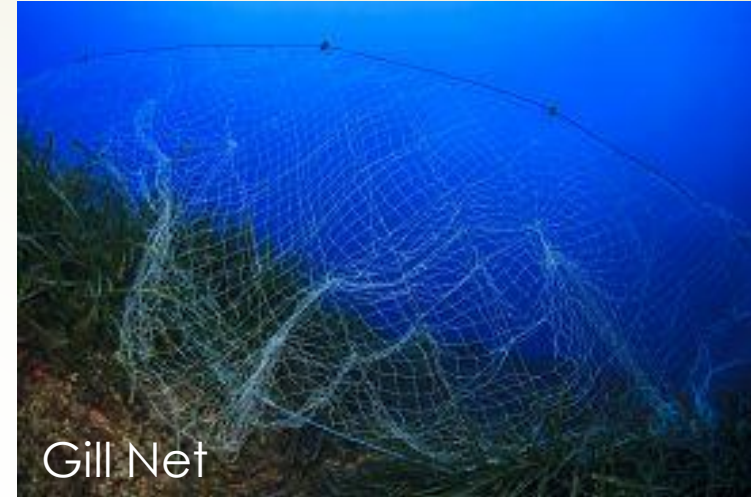


Channel Fish Sampling





Fyke Net



Gill Net



Cast Net



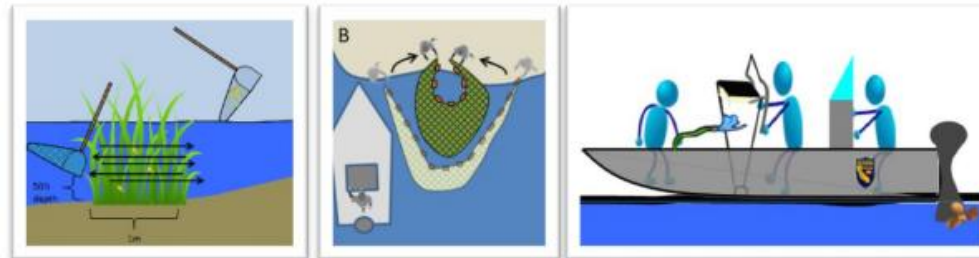
E-Fishing

Tidal Wetland Monitoring Framework for the Upper San Francisco Estuary Volume II: Standard Operating Procedures

8/17/2017

Version 1.0

Interagency Ecological Program Tidal Wetland Monitoring Project Work Team

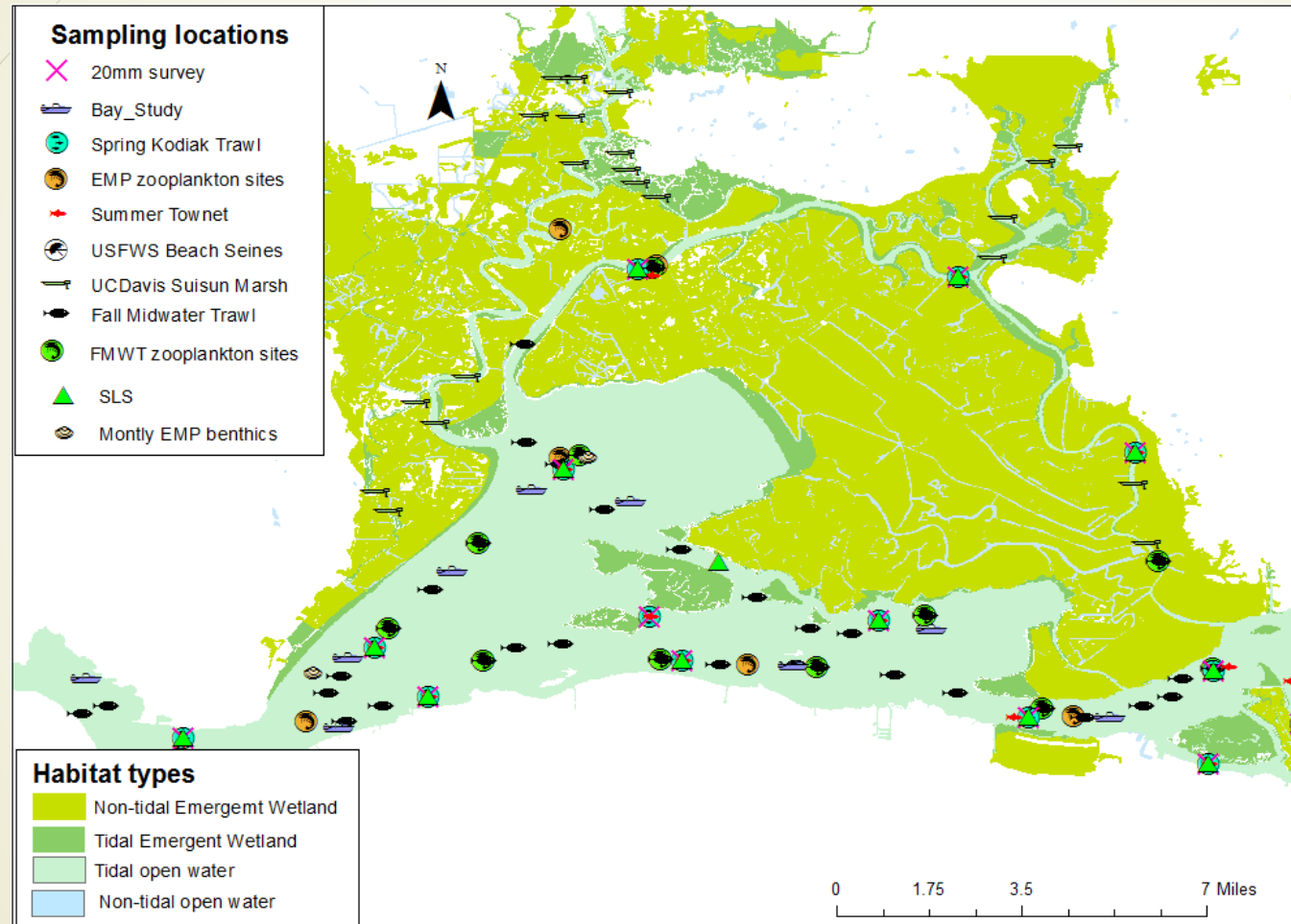


http://www.water.ca.gov/iep/about/tidal_wetland_monitoring.cfm

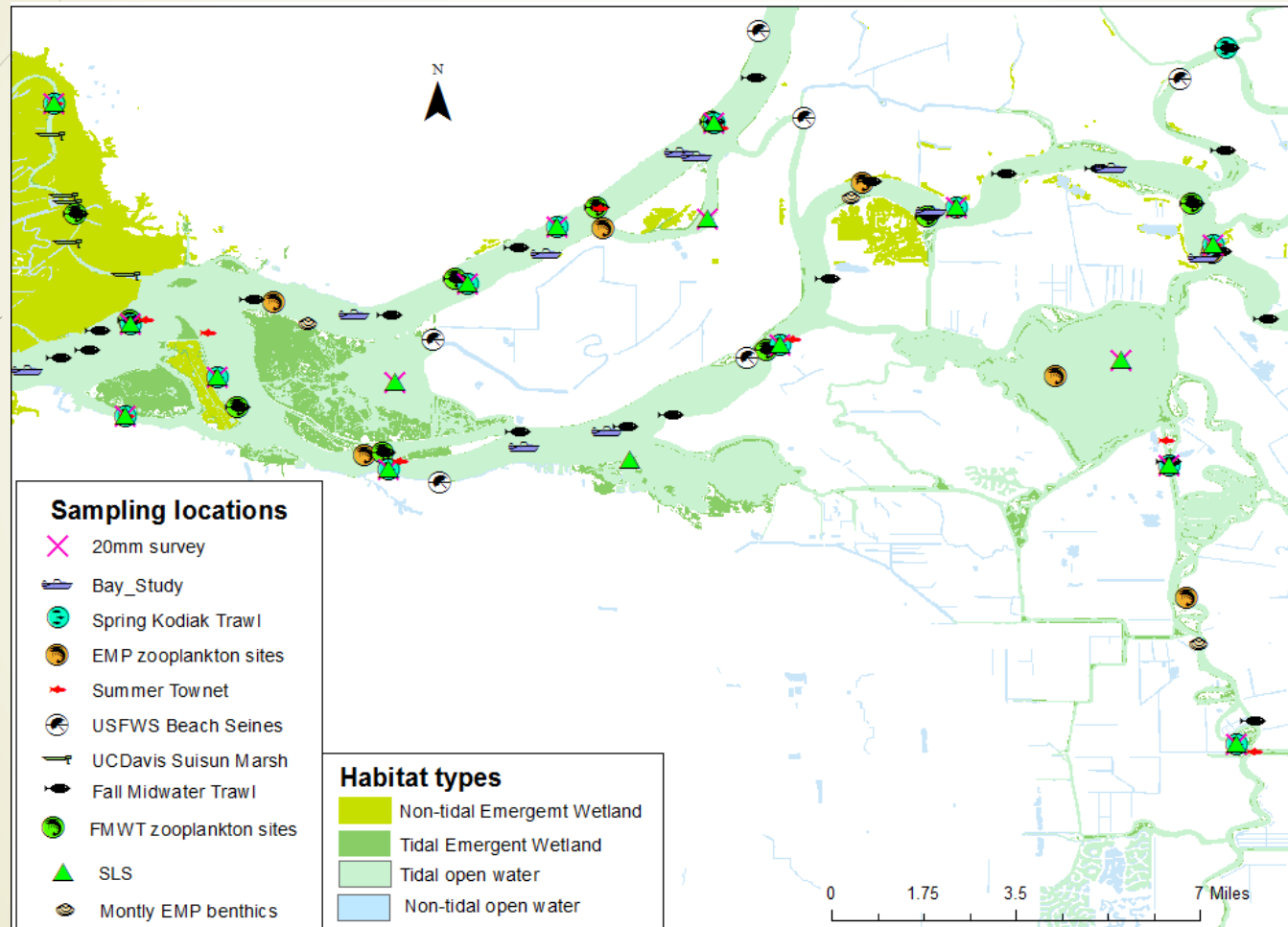
Existing data / programs

Monitoring Program	Agency
Chinook Salmon escapement estimates	CDFW, DWR
Chipps Island, Mossdale, and Sacramento Trawl Survey	USFWS
Continuous Water Quality Monitoring	USGS, CDWR
Delta Juvenile Fishes Monitoring Beach Seine	USFWS
Delta Regional Monitoring Program	CVRWQCB
Delta Smelt 20 mm Survey (20 mm)	CDFW
Environmental Monitoring Program	DWR, CDFW
Fall Midwater Trawl Survey (FMWT)	CDFW
Fish Salvage Monitoring	DWR, CDFW, USBR
North Delta Arc	UC Davis Moyle Lab
San Francisco Bay Study Survey	CDFW
Smelt Larval Study	CDFW
Spring Kodiak Trawl Survey (SKT)	CDFW
Suisun Marsh Fish Community Survey	UC Davis
Summer Townet Survey (STS)	CDFW
Yolo Bypass Study	DWR

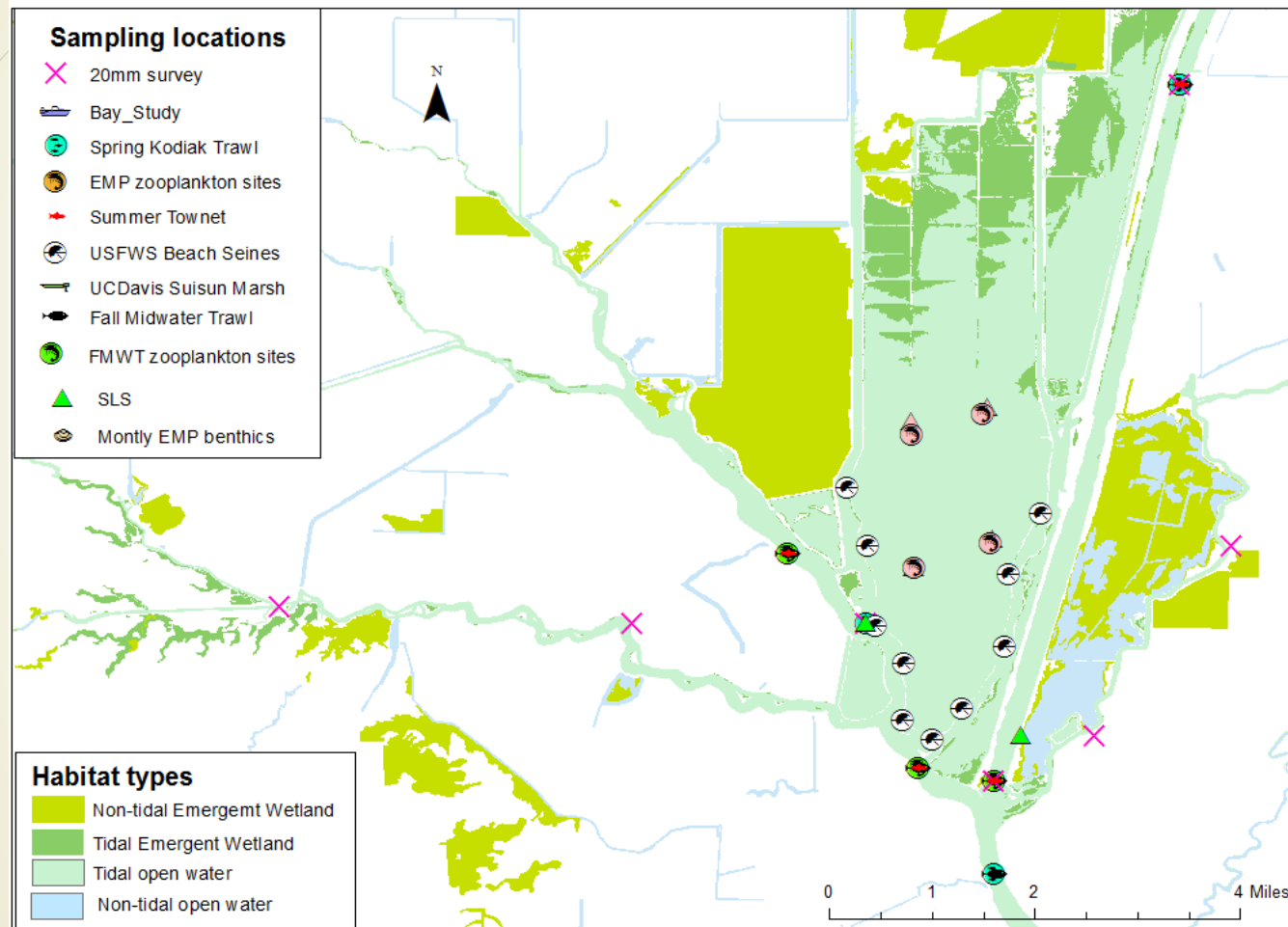
Existing data/ programs



Existing data/ programs

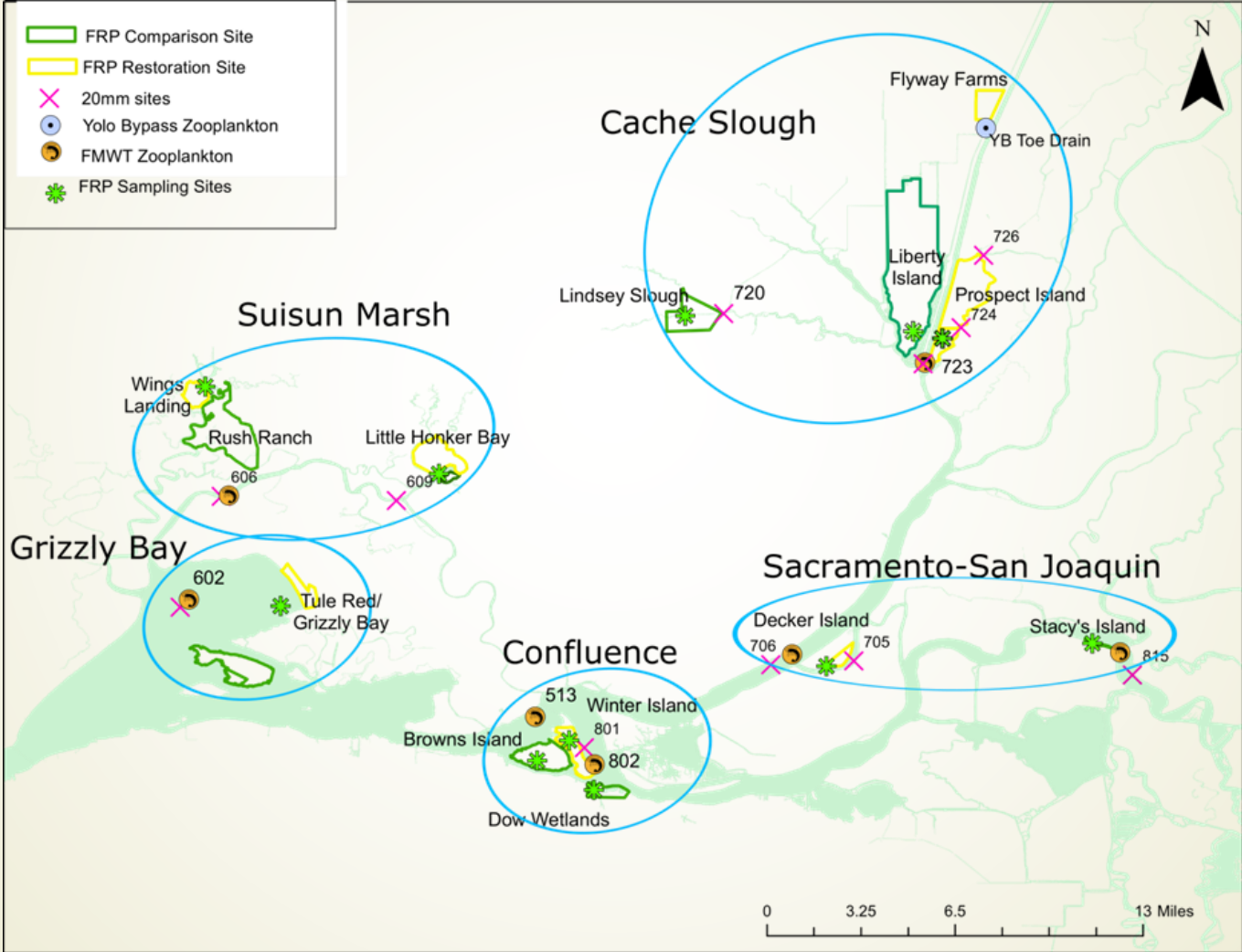


Existing data/ programs



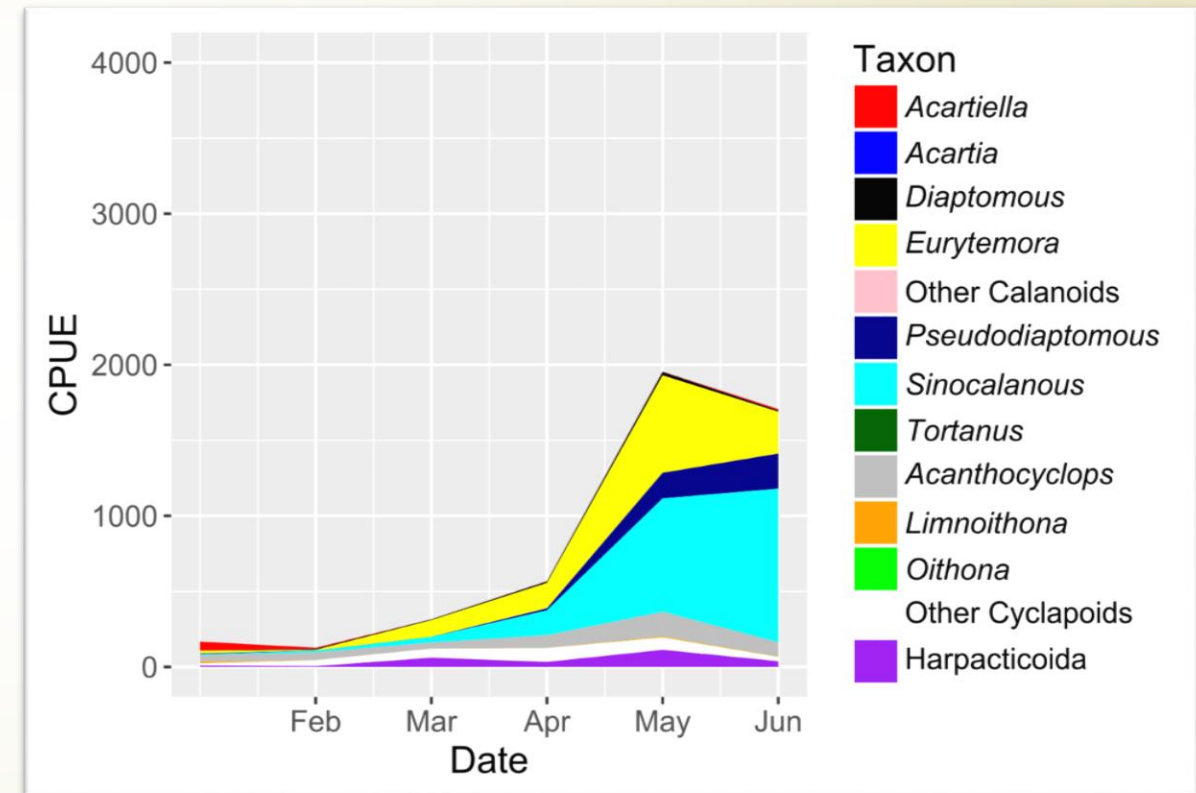
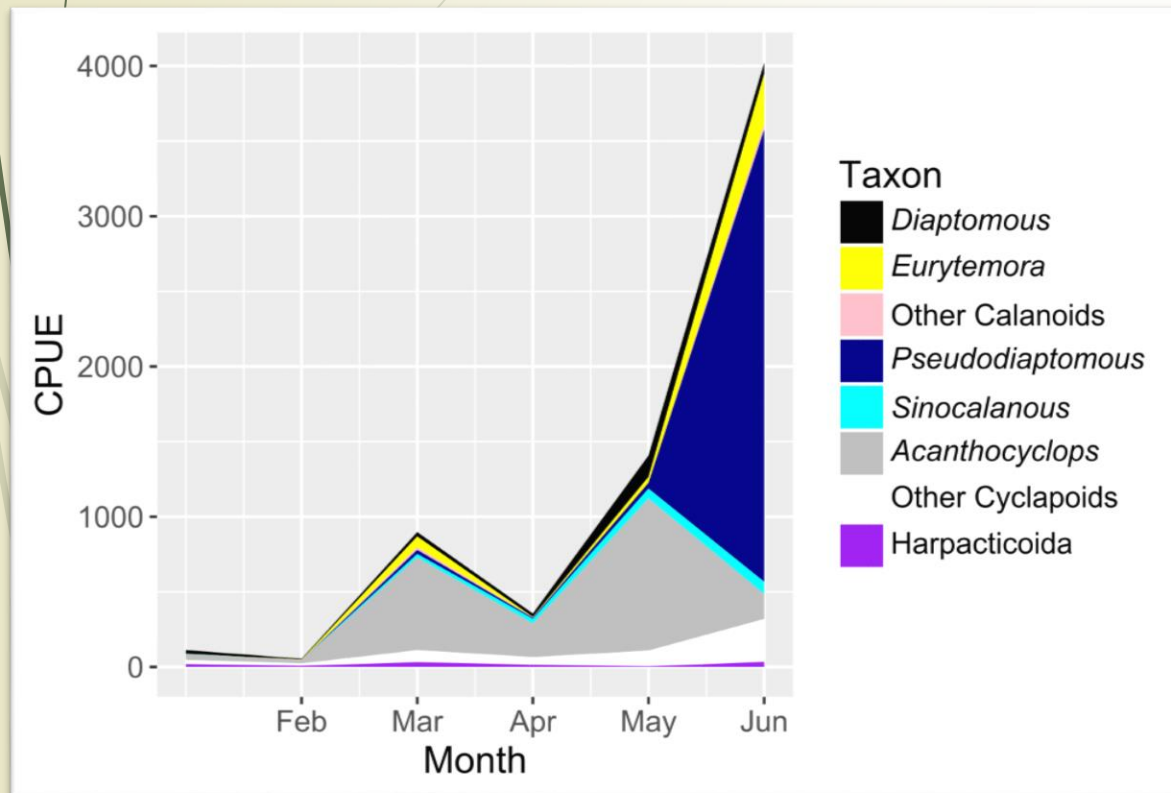


Pilot Phases III & IV: Zooplankton channel – shoal comparison



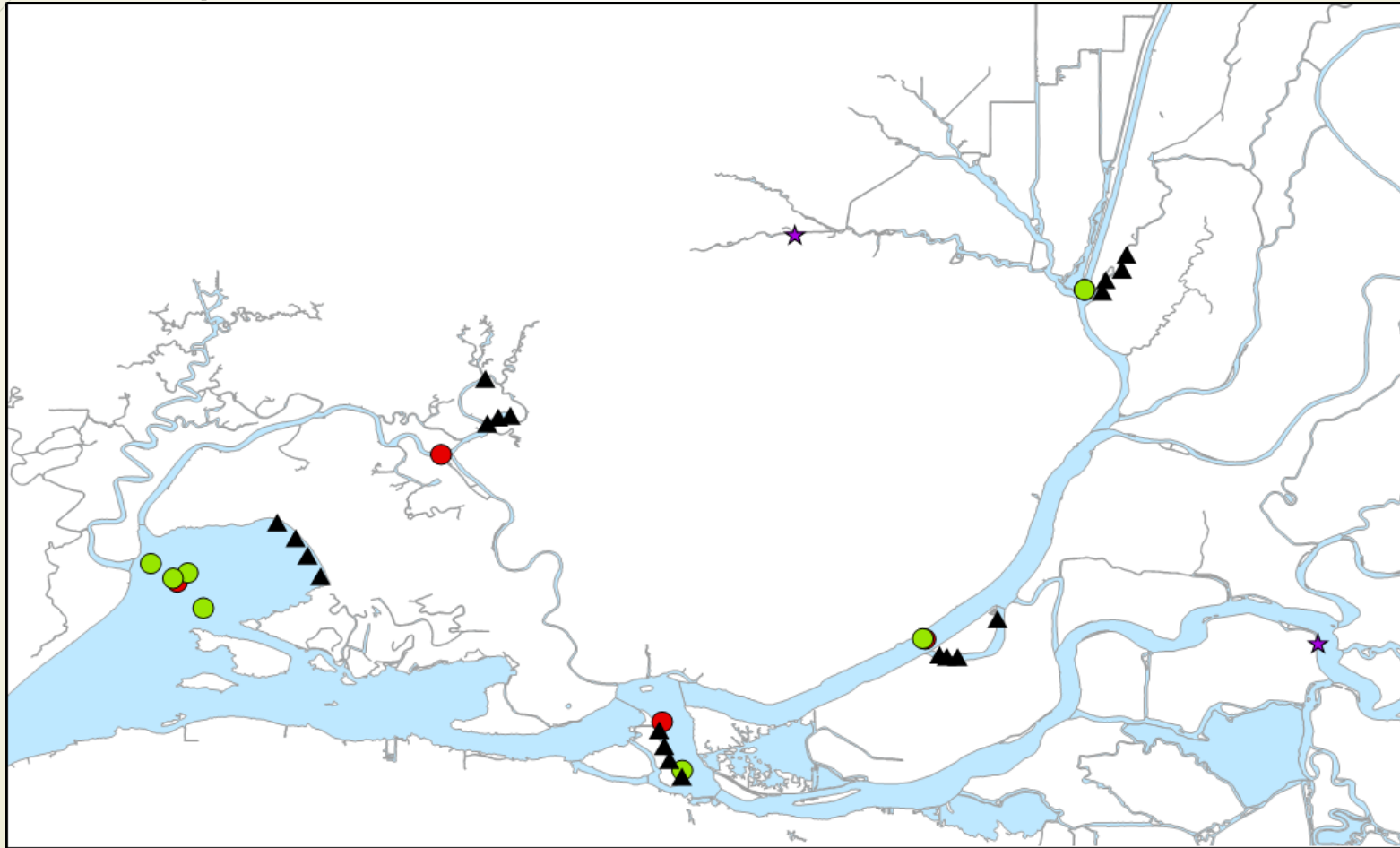
Zooplankton channel – shoal comparison

FRP – EMP near Decker Island 2017



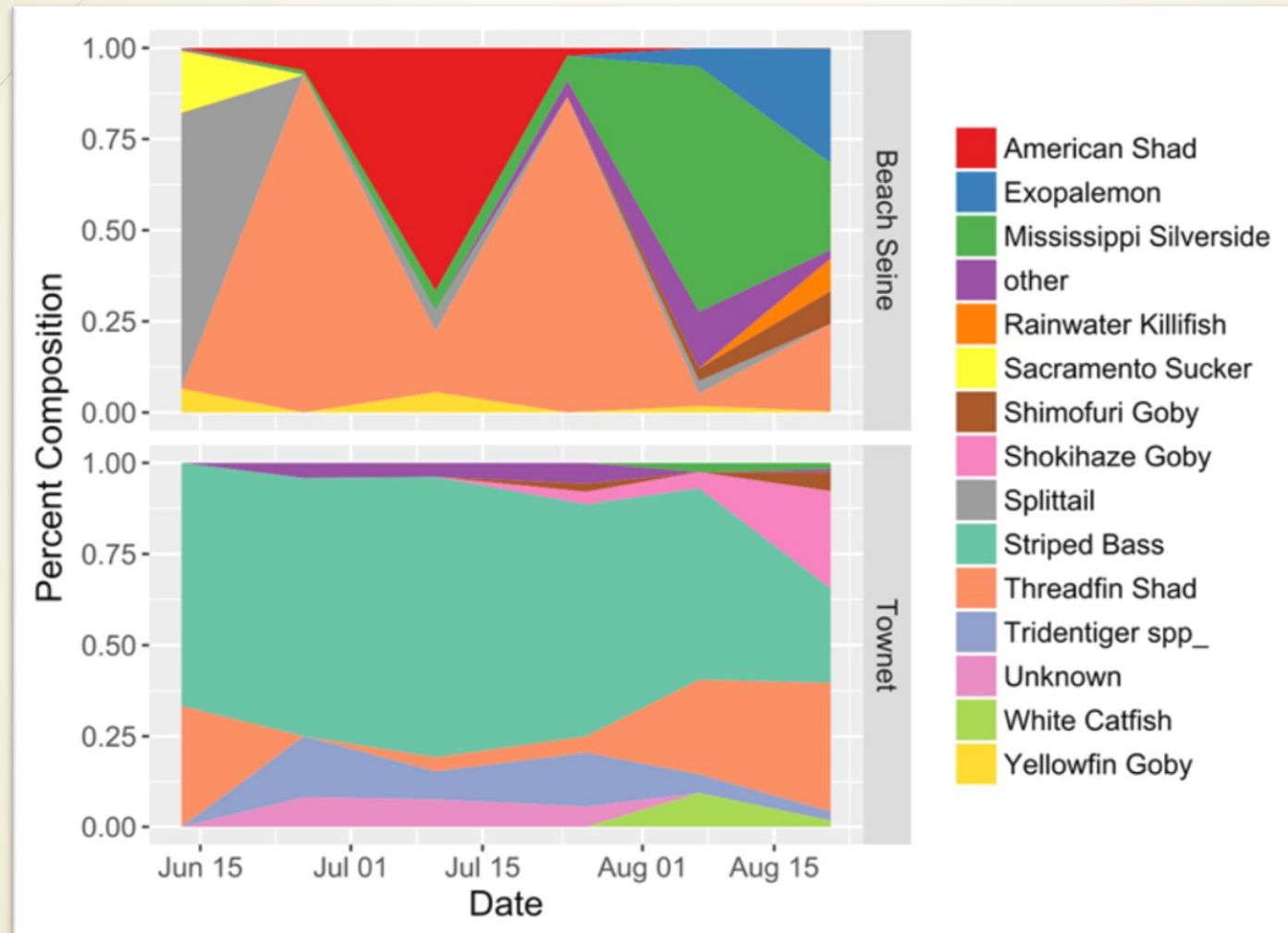
Thanks to Rosemary Hartman, Ryan Kok, and April Hennessey!

Pilot Phases III & IV: Fish channel – shoal comparison



Fish channel – shoal comparison

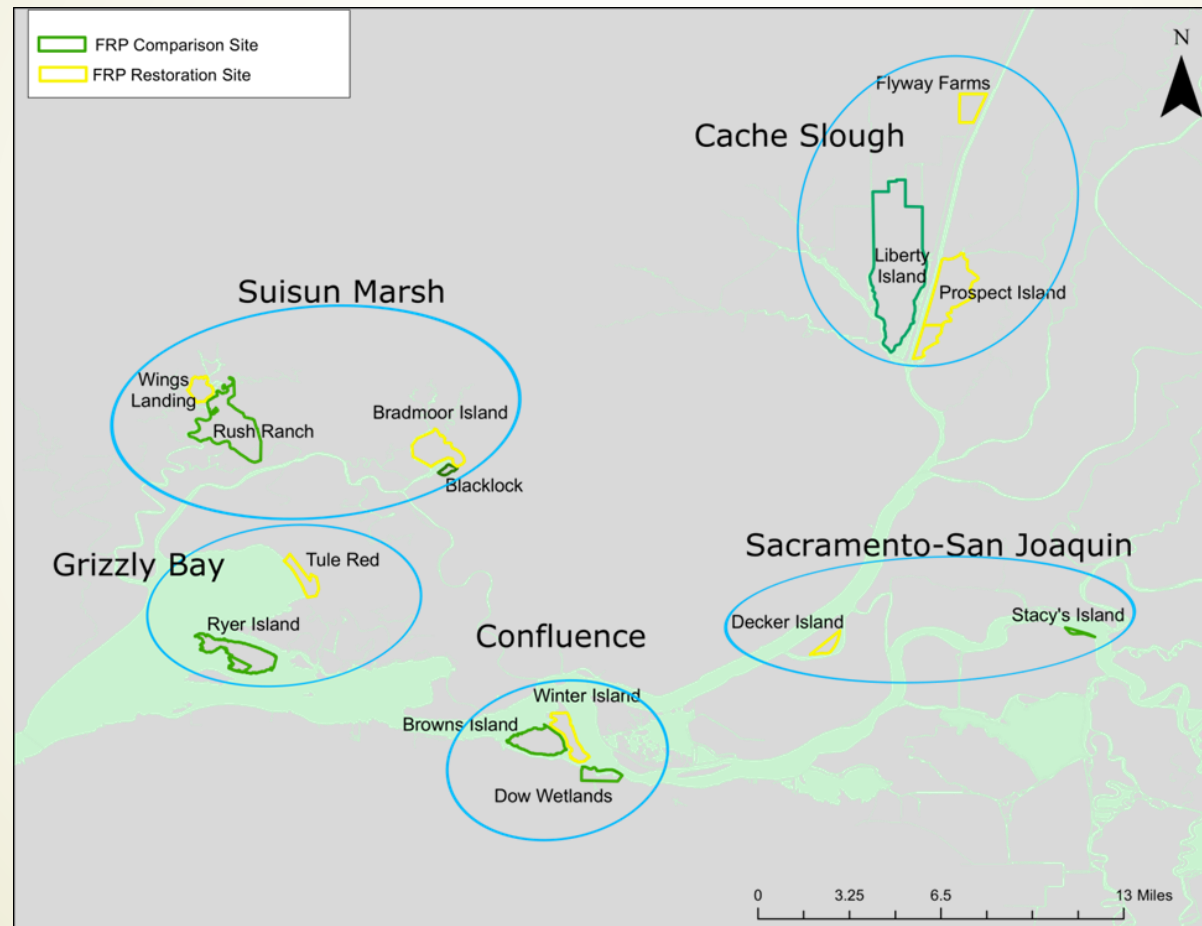
FRP – STN near Decker Island 2017



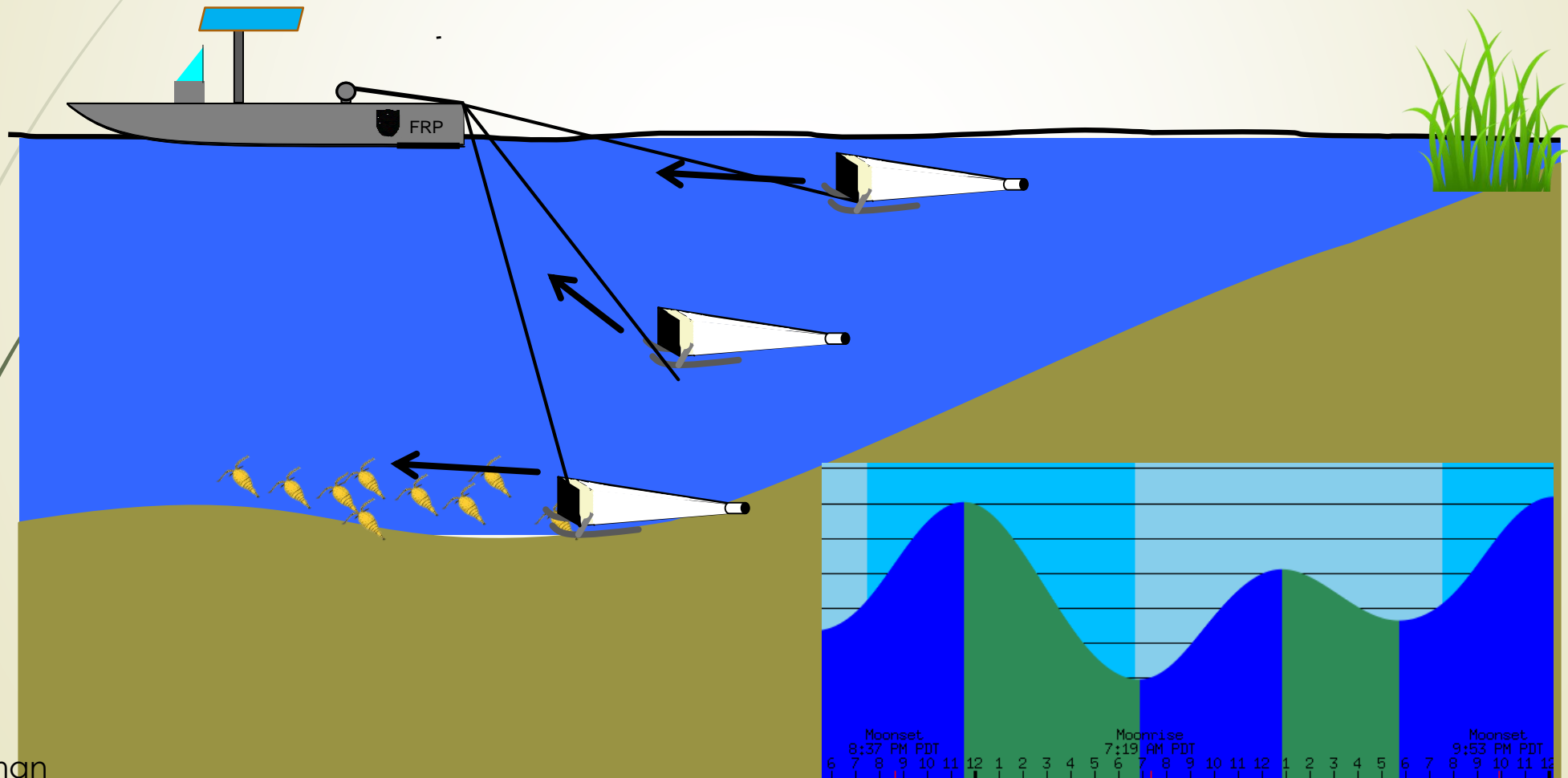
Thanks to Dave Contreras
and Rosemary Hartman!

Spatial and temporal variability

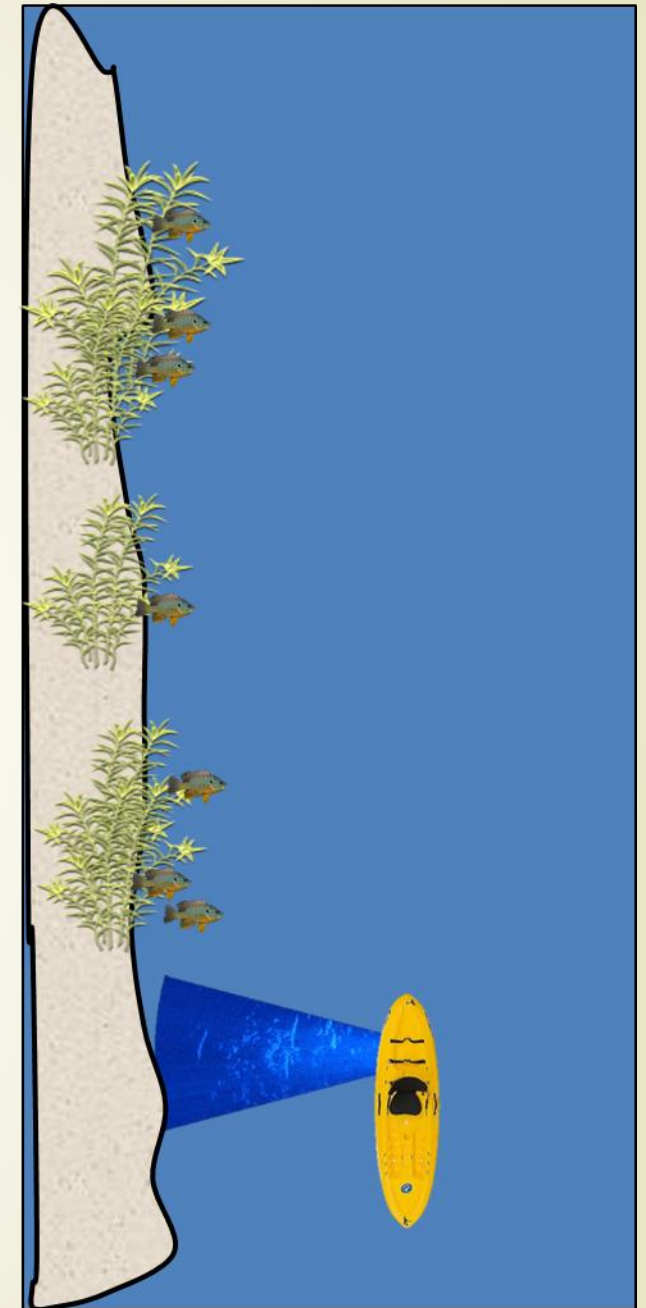
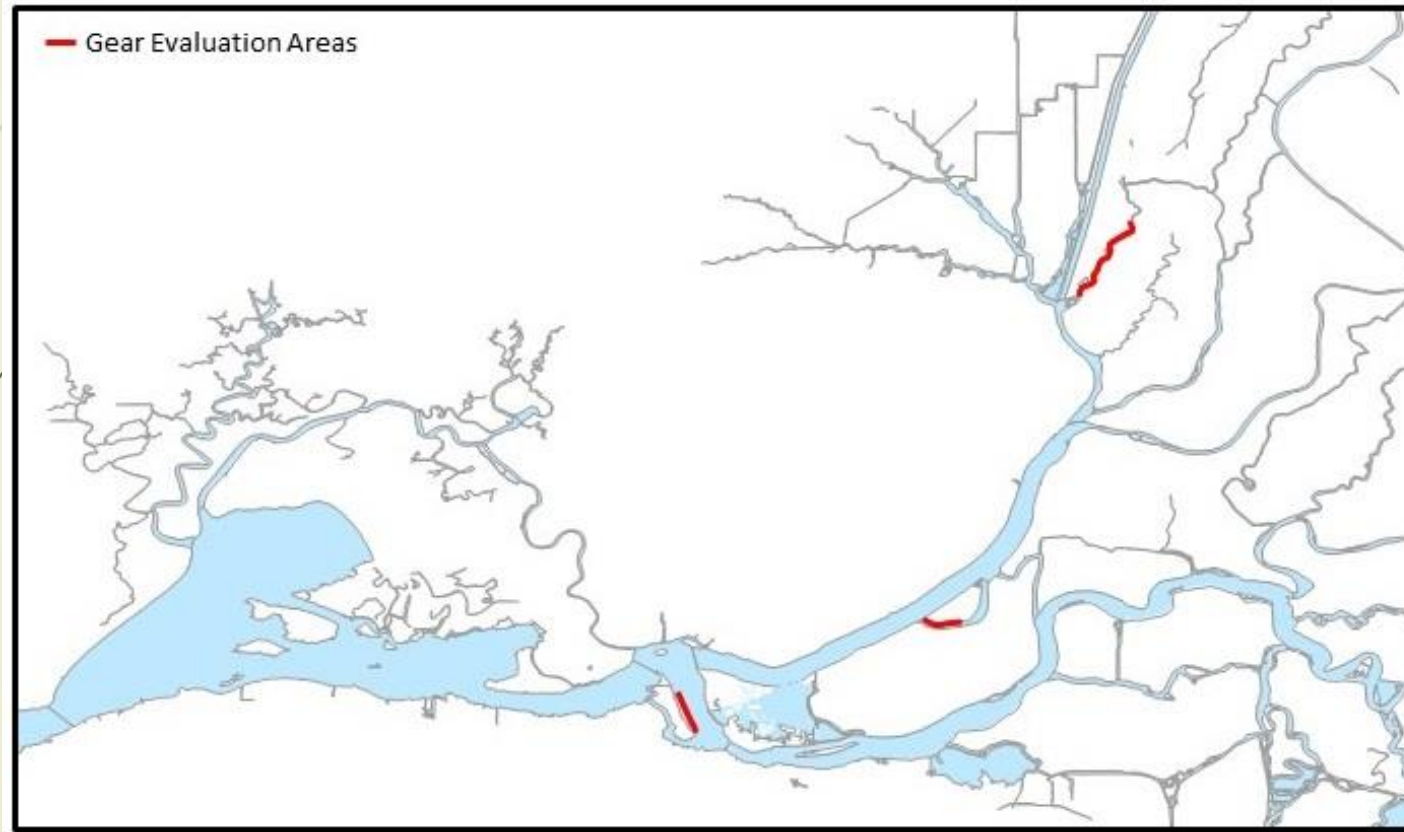
- Zooplankton and fish – 2017-2018 channel-shoal comparisons
- Macroinvertebrates – 2017-2018 sampling bouts + Decker Island longer term



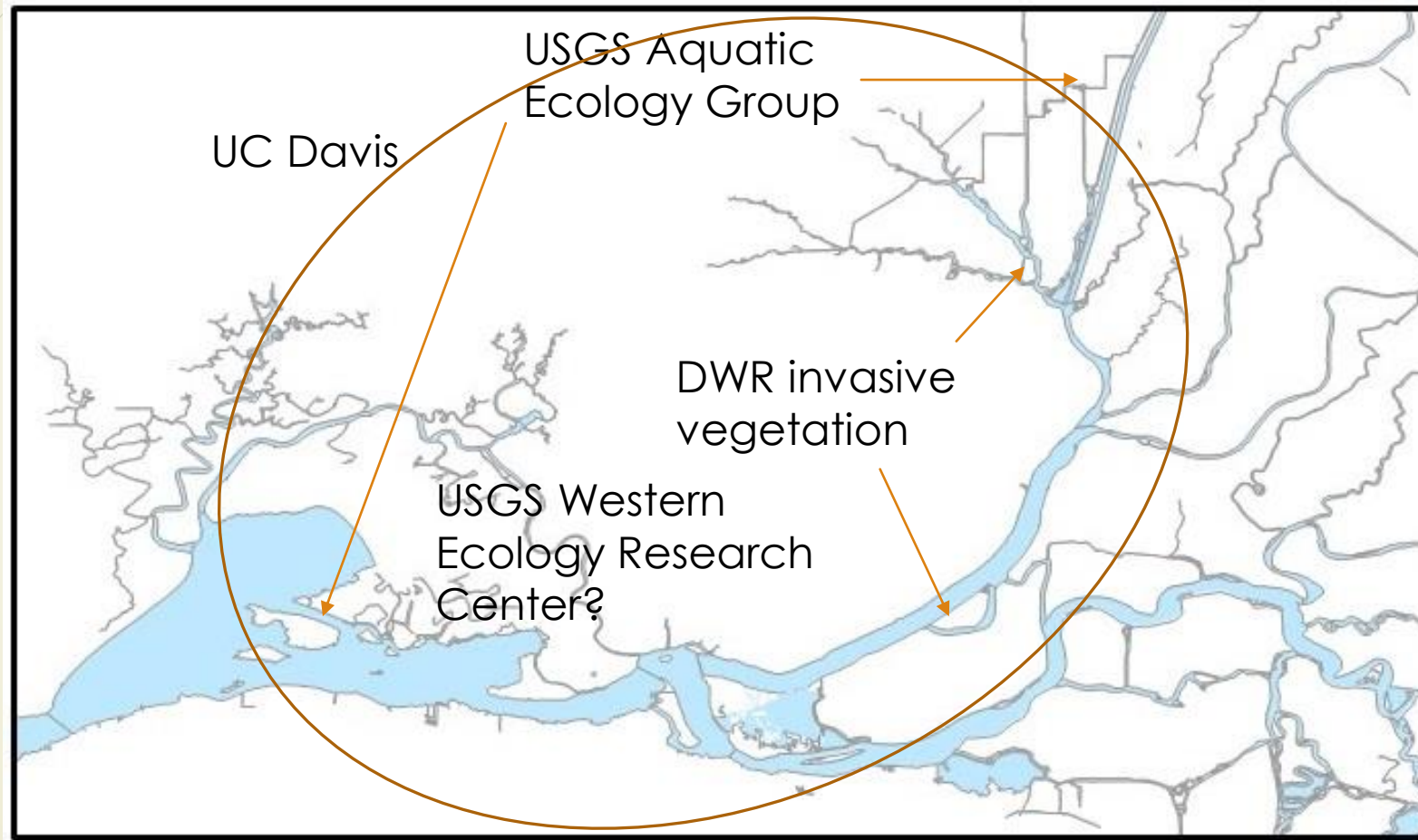
Special studies



New tech



Ongoing collaboration



Conclusion

Fish Restoration Program Effectiveness Monitoring

- ▶ Focus: impact of tidal wetland restoration on food resources for listed fish species
- ▶ Current: Pre-project + program development
- ▶ Future: 10 yrs post-construction per project (site + reference)
- ▶ Ideal: Characterize Capacity, Opportunity, and Realized Function for each site and the program as a whole.
- ▶ However, key constraints...

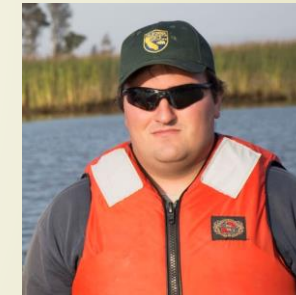
Constraints

➤ Access/safety



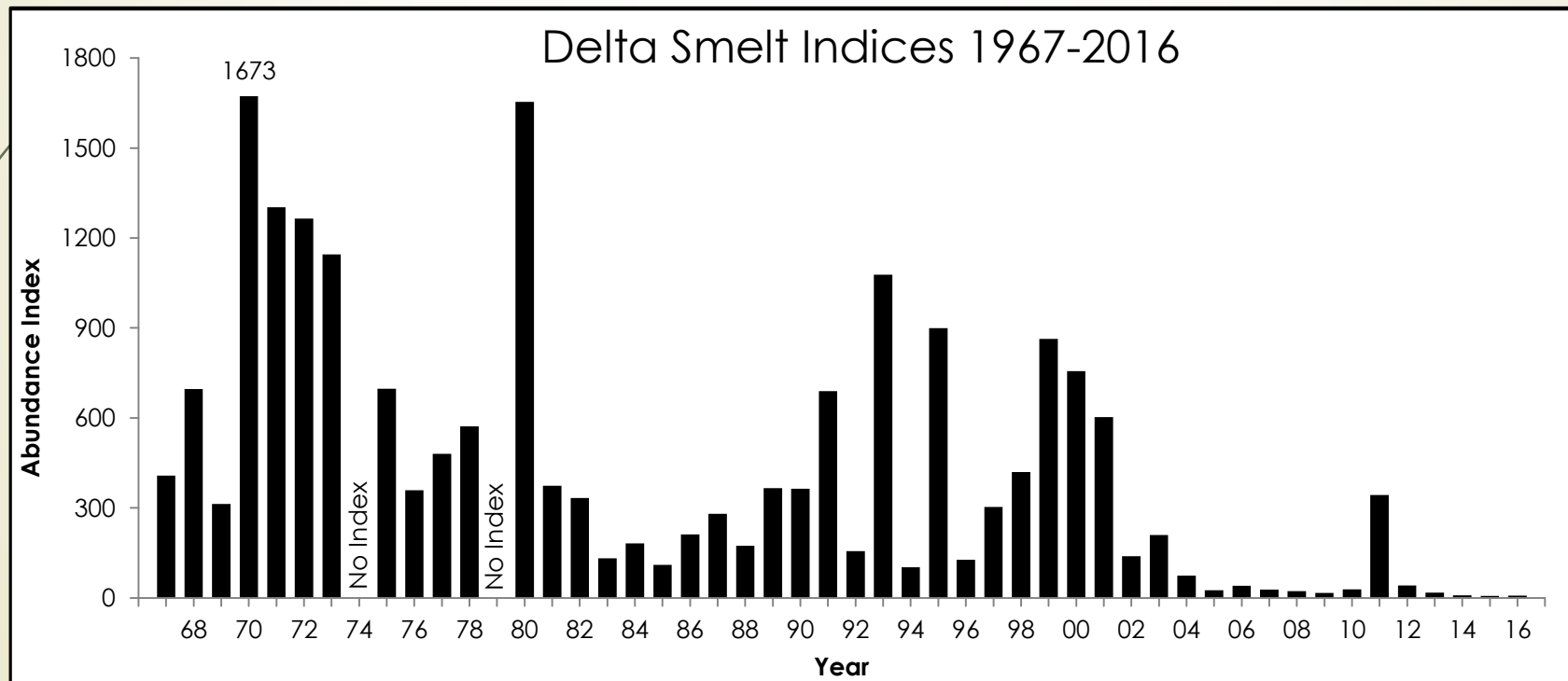
Constraints

- ▶ Time!
- ▶ 2018 work plan
 - ▶ Spring macroinvertebrate bout: 516 samples
 - ▶ Zooplankton channel-shoal comparison: 152 samples
 - ▶ Fall macroinvertebrate bout: 90 samples
 - ▶ Fish channel-shoal comparison: 244 samples
 - ▶ ARIS species validation: 60 samples
 - ▶ **Total 758 Invertebrate, 304 Fish samples**



Constraints

➤ Take



Constraints

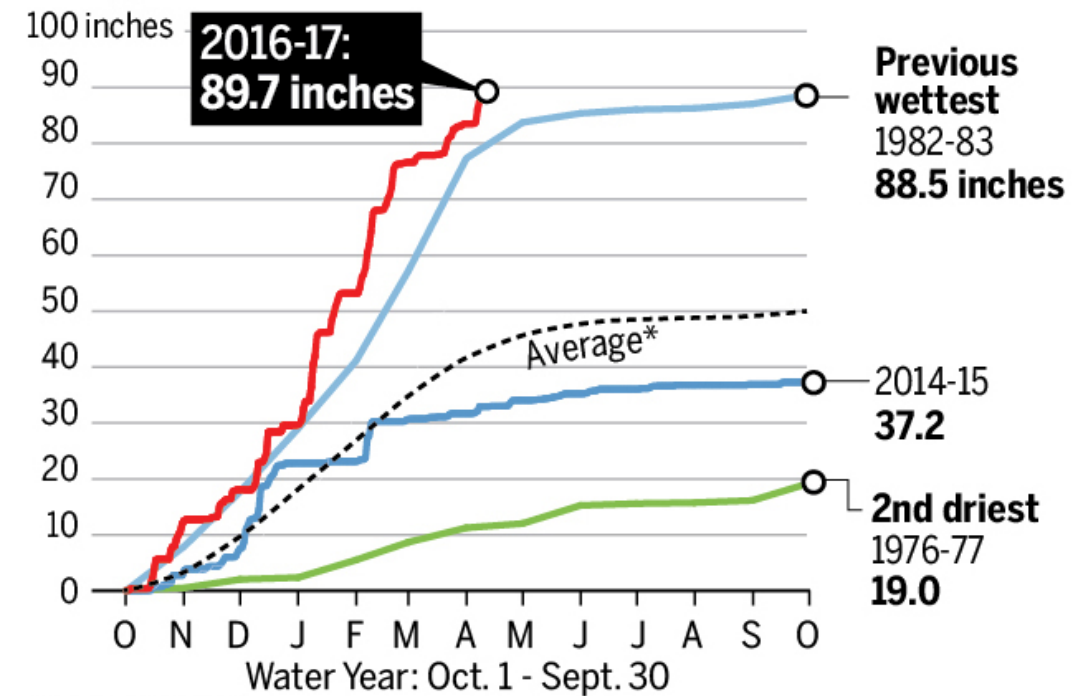
- Lack of flexibility in study plans



WETTEST WATER YEAR EVER

According to measurements from eight weather stations located in the northern Sierra Nevada region, where they have been tracking rainfall since 1922, 2017 finds the region at 207 percent of average as of April 13, an all-time record.

Cumulative daily/monthly precipitation averaged across the 8 stations



*From 1922-98

Source: California Department of Water Resources BAY AREA NEWS GROUP

Wetland-related Monitoring

- ▶ Gaps
 - ▶ Monitoring non-FRP projects
 - ▶ Species that aren't listed
- ▶ Meeting management needs?
- ▶ Helpful review
 - ▶ Inventory; coordinating the coordination
 - ▶ Realistic long-term vs. special studies